STATISTICAL MODELING OF RELATIONSHIP BETWEEN STATIC AND DYNAMIC ANTHROPOMETRY OF WOMEN

BY

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CANDIDATE'S DECLARATION

I hereby, declare that the thesis or part thereof

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CERTIFICATE I

This is to certify that the dissertation entitled "**STATISTICAL MODELING OF RELATIONSHIP BETWEEN STATIC AND DYNAMIC ANTHROPOMETRY OF WOMEN"** submitted by **MS. MADHURI S. KULKARNI** to the Marathwada Agricultural University, Parbhani for award of the degree of **DOCTOR OF PHILOSOPHY** in **HOME MANAGEMENT**, is a record of original and bonafide research carried out by her under my guidance and supervision. The dissertation, in my opinion is of sufficiently high standard to warrant its presentation for the award of the said degree. I also certify that the dissertation or part thereof has not been previously submitted by her for any degree, diploma or distinction to any other University / Institute.

The assistance and help rendered during the course of investigation and sources of literature have been duly acknowledged

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CERTIFICATE II

This is to certify that the dissertation entitled "**STATISTICAL MODELING OF RELATIONSHIP BETWEEN STATIC AND DYNAMIC ANTHROPOMETRY OF WOMEN"** submitted by **MADHURI S. KULKARNI** to the Marathwada Agricultural University, Parbhani in fulfilment of the requirement for the degree of **DOCTOR of PHILOSOPHY (Home Science)** in the subject of **HOME MANAGEMENT** has been approved by the student's advisory committee after oral examination in collaboration with the external examiner.

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(MADHURI S.KULKARNI)

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INTRODUCTION

Home is a workshop where multifarious activities are carried out and the domestic work is considered to be one of the world's major occupations. According to various time studies, on an average an Indian woman spends 40 per cent of the day in performing the household work. (George and Bafana, 1982; Varghese *et al.* 1989; Masur and Surendra, 1990; Kulkarni and Murali, 1991 and 1994 and Kulkarni *et al.* 1993). According to Varghese *et al.* (1989) household work demands a high degree of physical effort leading to fatigue. Performance of household activities, which is a full time occupation in India, is ignored in terms of its layout, size and proper arrangement. Women have to work harder and their optimum efficiency cannot be achieved mainly because workplaces are not ideally designed. Hence, to obtain the maximum efficiency in work with least strain to the body, there should be an ideal relationship between work, worker and workplace (Braton, 1992). The major causative factor responsible for this is the static muscular effort and adopting unnatural posture mainly resulting from mismatched work surface and heights of shelves.

To make house a delightful place to work, as a pleasing phenomenon, care should be taken while planning different work centres in the house. Thus, planning the house should aim at creating functional design of different workplaces, which contributes to the smooth flow of work. Workplaces are a major part of the team that is needed to accomplish various household works. The quality of the design of workplace in terms of the requirement of the worker has an important effect on ease with which the activity is accomplished. The problem of relating task and worker requirement for design of workplace is described by the term ‘functional design’. The creation of the functional work centres of the home should take cognizance of efficiency and should involve study of the worker and constituents of job. This will help the worker to work with less time, energy and maintenance of good posture, which in turn reduces fatigue and maintain health of the worker.

Adequate space is especially important where a woman is dealing with cupboards and shelves. Adoption of improper work heights and unnatural postures hasten the onset of fatigue and may lead to degenerative changes in long run. Provision of work surface and storage facilities at comfortable heights facilitates the maintenance of good posture. According to Agan (1970) conveniently designed work areas make the task pleasant, work surface heights convenient to the worker, reduce energy cost and prevent fatigue. The right height for a work surface depends upon the anthropometric measurements of the worker and work position. The elbow height is an important parameter for determining the desirable height of work surface for household tasks performed in standing position. Women’s vertical reach is of critical significance for the layout of the cupboard space and shelving. Vertical reach can be defined as the radius of action of the upper limb with the hand able to grasp objects. For all manual operations horizontal reach must be determined at the height of the working surface, which for most people lies 8-10 cm below the elbow (Varghese *et al.*, 1989).

Steidl and Bratton (1968) reported that the correct height could be determined by the kind of work and the height of the worker. Work at a low surface causes a person to stoop a position, which tires the back muscles. The ways in which the relationship between the dimensions of the workstation and those of the user may determine the posture of worker. Determining and coordinating the requirement of task and worker can solve the problem of designing workplace, which will be functional from the worker's point of view. The object of considering the requirements of the worker in designing workplaces is to determine the conditions that result in a minimum of strain on the worker and require a minimum of effort to do the activity.

Human factor is system concerned with the relationship between human beings, appliances and the work environment. The object is to obtain the optimum balance between the human capabilities and the demands of the task. The central focus of human factors relates to the consideration of human beings in the design of the man made objects, facilities and environment that people use in various aspects of their lives. The objective of human factor is to enhance the functional effectiveness with which people can use them. The central approach of human factors is the systemic application of relevant information about human characteristics and behaviour to the design of the manmade objects, facilities and environment that people use. (Barnes, 1980)

Though studies of body measurements have been reported from time to time including the body proportion studies and contributions have been made towards the systematic study of the human body form for artistic and architectural use, detailed functional design requirements taking into account the ergonomic implications of body sizes were never specified. Anthropometry is fundamental to create a successful design of workplaces and equipment. It is critical for the designer to consider the human being intentionally and thoroughly from the conception of the design rather than as an incidental or add-on part of the design. The man machine interface decides the ultimate performance of the equipment and work system. Therefore, to achieve enhanced performance and efficiency of man-equipment system along with better comfort and safety of operators, it is necessary to design various tools, equipment and workplaces keeping in consideration the anthropometric data of worker, worker's capabilities and limitations (Kathirvel *et al.*, 2005)

Anthropometric data is one of the many sources of information or tools available for studying physical body size, which is one of vast number of human factors, that impact on establishing relationship between task, appliance and worker. The word "Anthropometry" means measurement of human body. It is derived from two Greek words 'Anthropo (s)' means human and 'Metricos' means of or pertaining to measurement. (Oborne, 1986 and Grandjean, 1988). The knowledge of anthropometric characteristics of the user population is necessary to establish the quantitative foundation in designing workplaces. The ways in which work is related to the individual vary greatly, yet it is very difficult to think of any work situation in which the application of anthropometry or anthropometric principles could not make the work environment healthier, safer and more efficient (Annis and McConville, 1990). Anthropometry is the subject, which deals with the measurement of the human external body dimensions and certain other physical characteristics of the body such as volumes, centres of gravity, inertial properties and masses of body segments. These include measurements of body parts, their strength and their ranges in motion. The major concern in anthropometry is confined to measurements of dimension because such data are fundamental to a wider range of design problems.

The type of anthropometric data which mainly interests ergonomists can be divided into two categories namely 'Static' or 'Structural' anthropometry and 'Dynamic' or 'Functional anthropometry'. External human body dimensional measurements taken when a man is placed in a rigid and static position are termed as static or structural anthropometry of human being. Static anthropometric data concern the fixed structural dimensions of the body, generally made between anatomical landmarks in stereotyped postures (Pheasant, 1988 and Chakrabarty, 1997) or can be called as simple dimensions of the stationary human beings (Oborne, 1986). These are the measurements of the bodily dimensions of the subject in fixed position. Measurements are made from one clearly identifiable anatomical landmark to another or to a fixed point in a space, which consist of a skeletal dimensions and contour dimensions. These measurements include the stature, mid-shoulder height, eye height, elbow height, hand length, body circumferences and body depth and breadth measurements.

The human body always is not rigid but rather always dynamic. The second class of anthropometry is described as functional or dynamic anthropometry. The dimensional measurements of human body with various movements taken into consideration in different adopted postures, which the work context demands, are termed as dynamic anthropometry (Chakrabarti, 1997) and also can be defined as compound measurements of the moving human being (Oborne, 1986). These data are collected to describe the movement of a body part with respect to a fixed reference points (Bridger, 1995). Dynamic anthropometric data include measurements of reach, angular ranges of various joints or clearance made under functional conditions and allowing the worker a certain degree of freedom to adopt natural postures for the performance of a given task (Pheasant, 1988). It includes the measurements of body in working position or during the movements associated with certain tasks. Dynamic anthropometry is required more than the static body measurements in the field of designs and is little complicated to measure than static measurements.

The static and dynamic anthropometry is sometimes called as 'Engineering Anthropometry', which is concerned with the design of the things people use (Stoudt, 1981). Static as well as dynamic anthropometric data are used in ergonomics to specify the physical dimensions of work spaces, equipment, function and clothing so as to fit the task to the man and to ensure that physical mismatches between the dimensions of equipment, work center and the corresponding user dimensions are avoided (Grandjean, 1988).

Even though it is said that man is highly adaptive to any situation where comfort is concerned, optimization is required. Both in public and private sectors various anthropometric mismatches are seen that are unknowingly being used. Legitimate guidelines to optimize the requirement of worker are not available. Those population groups that do not have their own anthropometric data use readily available data sources either directly or by conversion factors. The use of non-Indian anthropometric data in Indian designs often results in mismatches with the requirements of Indian users. Accidents and serious mistakes may occur if any design dimensions do not exactly match the body dimensions of specific group. Far more static anthropometric data are available than does dynamic anthropometric data even though functional measures are more representative of actual human activity. There is no systematic procedure for translating static anthropometric data into dynamic measurements (Sanders and McCormick, 1993).

The importance of anthropometric considerations in design is illustrated by Ashby's expressions (1979) "if a piece of equipment was designed to fit 90 per cent of the male U.S. population, it would fit roughly 90 per cent of Germans, 80 per cent of Frenchman, 65 per cent of Italians, 45 per cent of Japanese, 25 per cent of Thais and 10 per cent of Vietnamese". Due to significant variations in individual body size averages are obviously of little use to the designer. The enormous variations in body size among individuals pose a great challenge for the designer of equipment and workstations. It is not acceptable as a rule to design workplace to suit a phantom of the average person (Kroemer and Grandjean, 1997). Hence, the anthropometry explains that there is no “average” man. It is unwise to design for “Mr. and Mrs. Average” a mythical person with the mean stature. It can be seen very few individuals will be exactly of “average” height. Dr. H.T.E. Hertzberg, one of the country’s most distinguished research physical anthropologists in discussing so called average man indicated “there is really no such thing as an average man or woman.” There are men who are average in height or in stature or in sitting height but the men who are average in two dimensions constitute only about seven per cent of the population, those in three only about three per cent and those in four less than two per cent and there is no men average in as few as 10 dimensions. Therefore, the concept of the average man is fundamentally incorrect, because no such creature exists. This implies that the concept of an average man or an ideal body is becoming increasingly invalid and designers must expect users different from themselves (Panero and Zelnik, 1979). Therefore, it is necessary to accommodate a range of people depending on the nature of the design problem. In the use of anthropometric data it should be reasonably representative of the population that would use the item. The design cut-off points must be carefully selected depending on the design purpose (Kroemer and Grandjean, 1997).

In many instances the population of interest consists of people at large, implying that the design features must accommodate a broad spectrum of people (Stoudt, 1981). The workplaces to be efficient, should be designed to the measured range of the body size usually be conceived to accommodate fifth or ninety-fifth percentile so that the greatest portion of the population is served. This is a purely arbitrary practice, which has been found to be satisfactory in many circumstances to design for middle 90 per cent of population. This custom suffices well enough but consequence of mismatch take place for 10 per cent population (Pheasant, 1988).

The body and reach characteristics of people directly influence the designing of areas. The area of reach signifies the limits to which a person can stretch his or her hands to grasp materials and equipment required. A worker can reach any object in this area without stretching or moving other parts of the body. It is most comfortable area of work involving the least amount of energy and providing the most effective view of materials and actions for a particular job (Sethi and Malhan, 1993). But in general fewer functional than structural anthropometric data are available. Although clinician have long been interested in determining normal ranges of joint movement in healthy individuals to assist in assessment of patients. These data are not always quantified or even directly applicable to design problems.

There is paucity of full-scale anthropometric study on Indian women population. As a result Indian architects and product designers blatantly rely on western standards (U.S.A. and U.K.) by using conversion factor, which is quite erroneous. Indian women actively engaged in the household activities obtain unique sitting, squatting as well as standing postures quite in contrast to the westerner's chair bench complex. Hence, it becomes necessary to study the anthropometric parameters of a large cross section and in sufficient detail with objectives to provide as complete a picture as possible of the diversity in size and shape among women which could be used as a reference data in planning ergonomic workplace layouts, in evaluating area specifications in determining work surface heights, clearances, reach dimensions, zones of comfortable reach as well as in assessing work method techniques and postural demands during work performance, Thus, enhancing operability, safety, convenience and besides augmenting work efficiency and reducing rework costs.

Statistical information about body size is not in itself directly applicable to a design problem. The designer has to analyse in what ways anthropometric mismatches might occur and then decide which anthropometric data might be appropriate to the problem. Few studies have indicated that there is some relation between the static and dynamic anthropometry of woman but the exact relationship is not indicated by systematic research studies. Hence, the present investigation was carried out with the specific objectives to find out the quantitative guidelines on static and dynamic anthropometry of women and getting the useful perspective of exact relationship between static and dynamic anthropometry of women which will help the women, designers and architects in planning and designing work areas efficiently.

The objectives of the present study were:

1. To assess the static and dynamic anthropometry of selected women
2. To determine the relationship between static and dynamic anthropometry of women
3. To test the applicability of assessed relationship of static anthropometry with dynamic anthropometry and
4. To develop a statistical model on assessed relationship between static and dynamic anthropometry of women.

REVIEW OF LITERATURE

Anthropometry is one of the disciplines that establish the principles and standards for the design of equipment, workplace and motion pattern for different operations to bring them into harmony with the size, shape, mobility and structure of human body. The study enables the worker to work with highest precision, speed and safety with least efforts. Quetlset, the Belgian mathematician through his Anthropometric published in 1870 developed the idea of studying anthropometry as a subject in a more formal way (Chakrabarti, 1997). Anthropometry provides the single most portable, universally applicable inexpensive and non-invasive technique for assessing the size, proportions and composition of the human body (Pathak, 2006). An effort is required to apply such data to equipment and workplace design to enhance the efficiency, safety and comfort of the operator. Applied anthropometry is related with the use of anthropometric data in the design and construction of wide variety of items and is relatively a new discipline. A comprehensive review of literature is a must in any research endeavor as it provides a sound theoretical framework for research. It further, provides insight into the methods and material, procedures to be used to reach the objectives of the investigation and finally work out a basis for interpretation of findings.

Research carried out in the field of anthropometry and relevant to static and dynamic anthropometry of women is being reviewed and has been systematically oriented into a conceptual frame work and presented under following heads:

2.1 Static anthropometry of women

2.2 Dynamic anthropometry of women and

2.3 Statistical implications regarding anthropometry of women.

2.1 Static Anthropometry of Women

The type of anthropometric data which mainly interests ergonomists is categorised into two categories, Static and dynamic anthropometry. Structural anthropometry deals with the simple dimensions of the stationary human beings. The physical size of the person is related to his ability to function with machine and task. Whenever the human operator has to interact with his environment, it is important to have details of the dimensions of the appropriate body parts (Oborne, 1986). Static dimensions are measurements taken when the body is in a fixed or static position. They consist of skeletal dimensions between the centres of joints or contour dimensions. Many of these measurements have very specific applications however measurements of certain body features have rather general utility.

According to Agan (1970) conveniently designed work areas make the task pleasant. Work surface heights convenient to the worker reduce energy cost and prevent fatigue. The right height for a work surface depends upon the anthropometric measurements and work position. The height up to the elbow is an important parameter for determining the desirable height of work surface for household tasks performed in standing position.

Shahnawaz and Davies (1977) reported the anthropometric study of 400 Iranian steel workers. The findings indicated that the mean stature of Iranian steel worker was 168.17cm in the range of 151-188cm; eye height was 158.13 cm in the range of 140-176cm; shoulder height was 138.77cm in the range of 126-157.5cm; elbow height was 103.85cm in the range of 92-117cm and mean shoulder width was 43.75cm in the range of 37-52 cm Measurements of Iranian males when compared with those of American males showed that 90th percentile of American male stature would accommodate approximately 90 per cent of the German Population but only 50 per cent of the Iranian population. This indicates that the anthropometry varies with respect to population in different regions and hence, the data on anthropometry need to be collected separately with specific design problem and user group.

Davies *et al.* (1980) compared hand anthropometry of 51 West European females, 21 Indian and 20 West Indian females. The study indicated that the length of hand reported for European female was smaller (174.3mm) than the West Indian female (184.0mm) and Indian female (178.5mm). Distance between fingertip to elbow reported for European (414.9mm), West Indian (455.7mm) and Indian female (431.2mm) was varying significantly from each other. Further, it was found that out of 28 measurements of the European and Indian female measurements, five of the comparisons were significantly different, the remaining 23 showed no significant differences. The larger West Indian dimensions were demonstrated when comparison was made with Indian measurements.

Stoudt while studying the anthropometry of elderly in the year 1981 reviewed two reports from survey of U.S. Health and Nutrition Examination (1971-74) and U.S. Health Examination Survey (1960-62) and reported the information on anthropometry of elderly male and female. As per the report of U.S. Health and Nutrition examination the mean height of female was 63.6 inches with standard deviation of 2.5. The fifth and ninety-fifth Percentile values were 59.5 and

67.8 inches respectively. These measurements were drastically lower than the measurements of male.

The second report reviewed by Stoudt indicated the anthropometry of women between the age group of 65-74 years. The mean height of selected female group was 61.5 inches and fifth and ninety-fifth Percentile values were 57.5 and 65.5 inches respectively. Mean chest circumference was 35.7 inches with 30.9 as fifth and 41.0 inches as ninety-fifth percentile. Average waist circumference recorded was 33.1 inches with 26.3 and 40.7 inches as fifth and ninety-fifth Percentile respectively. Arm circumference noted for the female was 11.5 inches with fifth percentile of 9.2 inches and ninety-fifth percentile of 14.0 inches. The findings revealed that anatomic decrements with growing age ultimately reduced the anthropometric dimensions of female. Thus, it was found that anthropometric measurements vary with age and gender differences.

Pheasant (1986) conducted anthropometric survey among West German adults and Japanese adults. It was obvious from the study that stature of West German women was between 1520-1750mm which was more than that of Japanese women which was between 1450-1610mm. Shoulder height and elbow height of West German women was between 1240-1400 mm and 925-1075 mm respectively. The corresponding ranges for these measurements for Japanese women were 1075-1215mm and 895-1015mm. This was drastically lower than the West German women. All the measurements recorded were lower than that of the male group in both the regions.

Fluegel *et al.* (1986) recorded anthropometric measurements of East German adults aged between 18-59 years and observed that the 90 per cent of East German female were having stature between 1514-1707 mm, eye height between

1415-1597mm, shoulder height between 1232-1403mm, span between 1503-1735mm and elbow span between 757-881mm. All the measurements recorded were found to be lower than East German adult male.

An anthropometric survey was carried out by Moustafa *et al.* (1987) among randomly selected 4960 Egyptian female subjects in the age range of 20-65 years. Findings of the study indicated mean stature height as 160.6 cm in the range of 142-179.1cm, mean eye level height as 149.2 cm in the range of 131.2-167.2 cm, mean shoulder height as 130.6cm in the range of 115.2-146 cm and mean elbow height as 95.5 cm in the range of 84.2-107.1 cm Mean measurement for chest girth, waist girth and buttock girth were 90.6 cm, 75cm and 105.5cm in the range of 77.3-104.9 cm, 64.6-85.8 cm and 88.4-122 cm respectively.

Further, the study indicated that body dimensions varied significantly in the different age groups. An increase in most of the body dimensions was noticed in the middle age years and gradual decline with advancing age. Egyptian women in the age group of 30-40 years were found to have largest body dimensions with the exception of elbow height, knee height and waist girth. A gradual decrease of stature and many other body dimensions was observed after the age of 40 years. When compared with the data of European and American women it was found that the Egyptian women differed in body build and dimensions from European and American women.

Boussena and Davies (1987) studied engineering anthropometry of 25 female clients of employment rehabilitation centre and found that the average height was 1624 mm with standard deviation of 63.5, eye height was 1506 mm with standard deviation of 64.5 and elbow height was 986 mm with standard deviation of 43.1. Fifth and ninety fifth percentile values recorded for height of female were

1519 and 1728 mm, for eye height were 1400 and 1612 mm and for elbow height were 915 and 1057 mm respectively. The analysis of the results showed differences between anthropometry of employment rehabilitation centre clients, other disabled group and able bodied group indicating that the employment rehabilitation centre clients should be considered as a distinct group with regard to workplace design specification especially in the employment rehabilitation workshop.

Varghese *et al.* (1989) recorded the anthropometric measurements of 120 non-pregnant and non-lactating women between the age ranges of 21-50 years residing in Mumbai. The study indicated average height of women as 153.2 cm, eye level height as 142.1cm, acromion height as 127.9cm, waist height as 92.5cm, buttock height as 80.5 cm, elbow height as 96.1 cm, hand length as 16.7 cm, palm length as 9.4cm and total span as 156.5cm Mean values for circumference of women at bust point was 86.7cm, waist point was 80.1cm and hip point was 92.2cm Biacromial breadth of women was found to be 30.3cm There was 15-25cm difference between the fifth and ninety-fifth percentile values for above said anthropometric measurements indicating the variation in measurements among the women from same region. The collected anthropometric data was further, compared with the work of Nag *et al* (1986), Ray *et al.* (1983) and Eveleth and Tanner (1976) and found that the mean values did not demonstrate striking difference between the samples for stature and other heights in standing and squatting position.

Kroemer in 1989 conducted study on Engineering anthropometry with 5 U.S. anthropometric surveys and reported the U.S. civilian data on body dimensions of male and females in the age group of 20-60 years. The fifth and ninety-fifth percentile values were recorded for stature (149.5 and 171.3); eye height (138.3 and 159.3); Shoulder height (121.1 and 141.9); elbow height (93.6 and 108.8): hand length (16.4 and19.8); elbow to finger tip distance (38.5 and 56); chest depth (21.4 and 29.7) and elbow to elbow breadth (31.5 and 49.1) of female were found to be significantly lower than the anthropometry of male. These findings indicated that gender of the subject affect the structural anthropometric dimensions.

Fernandez *et al.* (1989) conducted anthropometric survey among 101 Korean female workers in the age range of 18-28years working in garment industry. The data was collected as part of a project to modify the workstations. Observations of the study reported average height of Korean female workers as 1580mm with standard deviation of 57; eye height as 1471mm with standard deviation of 55; shoulder height as 1280 mm with standard deviation of 53 and elbow height as 988mm with standard deviation of 42. It was also found that the body dimensions of Korean females differed from that of Western and Japanese females. Korean female industrial workers were 45mm shorter than U.S. females but 50mm taller than Japanese females.

Gite and Yadav (1989) surveyed 39 farm workers and studied 52 body dimensions necessary for the design of farm machinery. Further, the data was compared with the data of previous studies. It was reported that mean value of stature was 162.0 cm within the range of 149.6-171.6; eye height was 151.0 cm in the range of 137.6-162 cm; Acromion height was 134.6cm in the range of 124.5-145.2 cm, elbow height was 102.6cm in the range of 94.1-110.3 cm and olecranon height was 99.2 cm in the range of 92.1-106.1 cm Average Biacromial breadth and bideltoid breadth recorded was 35.7 cm and 40.8 cm with corresponding ranges of 30.5-45.7 cm and 35.4-44.5 cm. Average chest circumference was noted as 83.1cm in the range of 76.0-96.0 cm and span of farm worker was 170.3 cm in the range of 161.0-183 cm, palm length was 103 cm in the range of 9.3-11.7 cm. It was obvious from the study that some dimensions of Industrial workers surveyed by Sen *et al.* (1977) and the workers from Punjab (Gupta *et al.* 1983) were taller and heavier than those from the other country.

Gordon *et al.* (1989) measured and reported anthropometric data of US adults between the age group of 19-60 years. It was noticed that ninety-fifth percentile values for stature (1737 mm), eye height (1621 mm), shoulder/acromion height (1432 mm), elbow height (1074 mm) and span (1809 mm) of US women was found to be lower than US men.

Mebarki and Davies (1990) conducted anthropometric study on 666 Algerian females in the age group of 16-65 years. Mean stature of Algerian women recorded was 1576 mm in the range of 1432 to 1774 mm. Eye height was recorded as 1456 mm in the range of 1226 to 1639 mm. Mean shoulder height and elbow height of Algerian women was noted as 1313 mm and 970 mm in the range of 1173-1542 and 806-1170 mm respectively. Shoulder breadth of women was noted as 413mm in the range of 281-504mm and chest depth was recorded as 257 mm in the range of 180-370 mm. Further, the findings of the study indicated the fifth and ninety-fifth percentile values for stature as 1484 mm and 1667 mm; eye height as 1365 and 1578 mm; Shoulder height as 1221mm and 1405mm; elbow height as 854 and 1086 mm; shoulder breadth as 356mm and 470mm and chest depth as 195mm and 319 mm. When the females were grouped into different age groups it was observed that majority of anthropometric measurements declined with increase in age, differed with occupation and geographical region.

Li *et al.* (1990) found significant differences in anthropometric characteristics among three occupational groups of civilian Chinese in Taiwan. Female workers in heavy physical jobs had wider shoulder breadth, larger chest depth and wider waist breadth than females in light physical or clerical jobs.

Gite and Chatterjee (1991) reported anthropometric data of female agricultural workers from all over India except Konkan and Vidarbha region. It was clear from the study that mean stature of female was 150.21 cm in the range of 136.5-166.6 cm, eye height was 140.64 cm in the range of 124.5-159cm, acromial height was 126.54 cm in the range of 106-141.3 cm, elbow height was 96.38cm in the range of 81.50-108.50 cm Span and span akimbo of female workers was reported as 155.48cm and 80.18cm in the corresponding ranges of 137.70-173.50 and 70-94.30 cm Average chest depth, chest circumference and waist circumference of female reported was 20.30 cm, 81.89 cm and 75.72 respectively with corresponding range value of 12.5-29.70 cm, 65.50-108 cm and 52-101cm Mean values for hand length and palm length were 16.85 and 9.94 cm with respective ranges of 14.33-19.13 cm and 7.54-12.23 cm. It is clear from the study that static anthropometric dimensions have wide range among female agricultural workers.

Marras and Kim (1993) compared anthropometric characteristics between industrial and military populations in the United States. It was found that there were no significant difference in terms of length dimensions of females in industry and females in the army. However the variability in abdominal dimension was found to be greater in industrial population. It was indicated that this greater variability might be due to wider age distribution of the sampled industrial population.

Resnick (1995) found significant differences between female Colombians and the U.S. civilian adult female population on nine out of ten common body dimensions. The Colombian females were on the average 80mm shorter than U.S. civilian females. The difference in eye height was more than 90 mm.

Paul *et al.* (1995) evaluated working surface height and working surface areas for standing manual work in the condition of pregnancy. They had examined anthropometry of 27 women and stated the mean stature as 167.3cm and mean elbow height as 104.9 cm Study also indicated that as the body dimensions especially abdominal girth measurements of women get changed during pregnant condition the work surface heights and work surface areas need to be adjusted as per physiological state of women.

Ryszard (1996) studied anthropometric dimensions of 24 females and indicated mean stature as 165.1cm with standard deviation of 6.2 and mean shoulder breadth as 36.8 with standard deviation of 1.6 cm It was further found that shoulder breadth, sitting height and sitting shoulder height had the greatest influence on body posture of female.

Elisabeth *et al.* (1996) measured upper arm elevation of 16 female workers in the age group of 19-63 years engaged in statistical data entry job before and after change of work organization. Findings indicated that the mean height of these female workers as 166.1cm with standard deviation of 6.7.The difference between the upper arm elevation of female before and after the change of work organisation was mostly non significant. The arm elevation remained essentially below 30^0 during the working day and subjects worked with limited arm movements.

A study conducted by Robertson and Minter (1996) among 31 female motorcycle riders indicated that average stature of female population of motorcyclists as 1639.7mm, which was taller than the general population with, mean stature of 1639.7mm. The knee position indicated that there was wide variation in the forward position of the knee with range of 228mm.

AICRP Report of Hyderabad (1996) reported that height of homemakers in the age group of 20 - 40 yrs ranged between 136cm and 165 cm Study Further, indicated that with an increase in body height maximum and minimum reach measurements of homemakers in vertical and horizontal plane also increased. Maximum reach of homemaker in vertical and horizontal plane was 175-190 cm and 65-75 cm respectively.

From the report of AICRP Udaipur (1996) it was obvious that the age of respondents made no difference in various Anthropometric dimensions in the standing positions viz. Height, shoulder height, eye level height and elbow height. The miscellaneous anthropometric measurements of rural women showed almost no difference between the two age groups showing negligible effect of age on anthropometric measurement in various body positions.

Bhattacharya and McGlothlin (1996) derived anthropometric data of male and female and reported the data on average women from which it was clear that the average women was with stature of 1614mm to 1652mm, chest circumference of 891-930mm, hip circumference of 951-987mm and waist circumference of 771-821mm. These measurements were significantly lower than the stature of male (1745-1784mm), hip circumference (968-1004mm) and waist circumference (849-899mm). This indicated that females were having smaller dimensions than that of male.

Pheasant (1996) reported anthropometric data of British adults between the age group of 19-35 years. It was found that 90 per cent of female were having stature between 1505-1710 mm, eye height between 1405-1610 mm, shoulder height between 1215-1405mm and elbow height between 930-1085mm. Span and span akimbo of these 90 per cent of women was between 1490-1725 mm and 780-920 mm respectively. All the dimensions recorded were lower than the group of male adults.

Mououdi (1997) reported anthropometric measurements of 105 male and 74 female students from Teharan University within the age range of 20-30 years. Mean values recorded for stature, shoulder height, eye height and elbow height of female students were 159.7cm, 132.27cm, 148.63cm and 101.9cm respectively in the corresponding ranges of 147.30- 173.50; 121.10-144.5; 138-162.70 and 92.20-112.70cm. Mean measurement of fore arm to hand length was 42.33cm within the range of 35.40-46.80cm. Mean waist circumference recorded was 70.42cm between the range of 59.30-82.50cm These measurements were lower than the measurements of male students.

Rush *et al.* (1998) studied 42 Caucasian and 40 Polynesian female subjects in the age group of 18-27 years. It was observed that mean stature of Caucasian women was lower (1.647mt) in the range of 1.530-1.802mt as compared to Polynesian women (1.664mt), which was in the range of 1.534-1.782 mt. Mean abdominal girth was also found to be lower (82.5cm) within the range of 61.7-115.4 cm for Caucasian female than that of Polynesian women (87.1cm in the range of 66.0-130.2cm). Thus, the study indicated that the mean difference in anthropometric measurements is randomly distributed for each ethnic group.

Botha and Bridger (1998) studied 100 full time nurses in Western Cape and recorded selected anthropometric measurements. It was clear from the study that mean stature of nurses was 1630 mm in the range of 1388-1710 mm; shoulder height was 1355 mm within the range of 1247-1532 mm; elbow height was 1003 mm in the range of 889-1137 mm and hip height was 874 mm in the range of 789-996 mm. Mean values for hand length and palm length were 184 and 109 mm in the corresponding ranges of 151-205 mm and 62-128 mm. The study confirms the findings that nursing is stressful profession, which is due to variability in body and mismatch of work equipment as well as workspaces. The variability in Western Cape population was noticed due to ethnic and biological origin.

Sumangala and Ogale (1999) stressed the felt need to know one's easy, comfortable and maximum reach to plan the satisfactory storage as it helps to determine the total height and top most height of the shelf.

Liu *et al.* (1999) studied 110 female operators in a Maquiladora plant in the age group of 17-39 years for 12 anthropometric measurements. Mean height of these female workers was recorded as 1535mm in the range of 1389-1685 mm; Mean eye height was 1428 mm in the range of 1273-1598 mm and mean elbow height was 956 mm in the range of 835 mm- 1073 mm. Mean distance between elbow to middle finger and biacromial was 415mm and 342mm in the range of 338-460mm and 241-447mm respectively. Mean value for hand length was recorded as 169mm in the range of 149-190mm. Further, it was concluded from the study that Korean female were different from the Western and Japanese female with respect to selected anthropometric measurements like height, eye height, shoulder height, elbow height and hand length which were lower than the British and U.S. female population but higher than the Japanese female population.

However the relative body proportions of the Korean female are more like those of western female than those of the Japanese female. This indicates that female population varies in body dimensions with different geographical zones. Further, the study indicated that Maquiladora females in the age group of 25-29 and 30-39 were smaller in height (1525mm and 1528mm) than those of Mexican American females who were having 1582mm and 1577mm height and 360mm and 362 mm biacromial breadth. On the whole it was found that the Maquiladora females were 47 mm shorter in stature, 18mm smaller in biacromial breadth and 25mm wider in bitrochanter breadth than the Mexican American females. Author further compared the data of Maquiladora females in the study with anthropometric data of Japanese, Colombian, HHanes, Korean and U.S. ohio females and found differences in various body dimensions of Maquiladora females as compared to Mexican American females, Korean industrial females. The Mexican American females were taller and had wider shoulder breadth than the Maquiladora females. On an average Maqiladora and Japanese females shared similar anthropometric characteristics.

Wang *et al.* (1999) measured 1200 workers (735male and 465 female) in the age group of 18-60years from Taiwan's main industries and presented report on static and dynamic anthropometry of these workers. It is clear from the report that mean stature of female (1563.2mm), shoulder height (1280.2mm), eye height (1449.8mm), elbow height (973.3mm) and waist height (911.3mm) was lower than the mean values for male workers. This indicates that there are variations in anthropometric measurements as per the gender.

Chaffin *et al.* (2000) studied a group of 18 female and 20 male drivers with the average age of 34.2 years and 36.3 years respectively. Findings showed that average stature of female drivers was lower (162.2cm) than that of male drivers (175.2cm). Thus, it was revealed that in reach motions anthropometry is a very important demographic variable and age to a much lesser degree, gender also account for some consistent differences in the selected anthropometric measurements.

Vasu and Mital (2000) studied anthropometry of 70 male and 70 females and indicated fifth and ninety-fifth percentile value of stature for male (161.54 and 185.40cm) were higher than the stature of female (153.06 and 171.94cm) which indicated that the male population was taller than the female population. A comparison between sample mean percentiles and corresponding population percentile values given in the published literature indicated that a certain percentile stature person would not have other body dimensions in the same percentile.

Verma and Oberoi (2000) reported vertical and horizontal measurements of women from Hisar, Ludhiana, Hyderabad, Udaipur, Pantnagar and Dharwad. It was observed that mean stature and eye height of Dharwad women was lower (149.40 and139.29) as compared to the stature and eye height of women from Hisar (157.44cm and 145.91cm), Ludhiana (156.79cm and 144.08cm), Hyderabad (152.54cm and 142.46cm), Udaipur (151.99cm and 141.78cm) and Pantnagar (151.97cm and 140.21cm) whereas, mean shoulder height and elbow height was found to be lower in case of female from Pantnagar (126.26 and 95.75cm) than the female from Hisar (132.50and 112.89cm), Ludhiana (130.81 and99.69cm), Hyderabad (127.61 and99.44 cm), Udaipur (126.99cm and 98.90cm) and Dharwad (126.74 and 97.21cm).

Mean squatting height reported for Dharwad women was less (76.97cm) as compared to the squatting height of women from Hisar (79.20cm), Ludhiana (82.78cm), Hyderabad (77.78cm), Udaipur (78.06) and Pantnagar (81.68cm). Squatting eye height and Shoulder height of women from Ludhiana was lower (64.14 and 54.13cm) than the women from Hisar (67.43 and 57.76cm), Hyderabad (68.36 and55.99cm), Udaipur (68.95 and 55.98cm), Pantnagar (70.31and 57.14cm) and Dharwad (67.76 and 55.61cm). Total arm length (71.56cm) of women from Hisar was more whereas, palm length of Pantnagar women (18.56cm) was more as compared to the measurements of other women. It was concluded from the study that there are variations in structural anthropometric measurements of women from different zones in India.

Okunribido (2000) had conducted anthropometric survey measuring 18 dimensions of the right hand in 37 female from rural force workers living in western Nigeria and compared with those for females from U.K., Hong Kong and South America. The results suggested that Nigerian female hand was wider and thicker than that of their foreign counterparts.

Kothiyal and Tettey (2000) conducted survey among 138 elderly female subjects in Australia and recorded 22 body dimensions relevant to design of living facilities, equipment and workplaces for the elderly people. The mean values for stature, eye height, shoulder height, elbow height, shoulder breadth, chest depth, elbow to finger tip length and hand length were recorded as 152.1cm, 141.4cm, 127.1cm, 95.2cm, 35.6cm, 23.5cm, 38.5cm and 17 cm respectively. The corresponding fifth and ninety-fifth percentile values noted were 141.2-162.7cm, 129.7-152.0cm, 117.1-138.4cm, 85.5-104.9cm, 30.7-41.7cm, 17-31.8cm, 33.7- 44.2cm and 15.3-18.8cm. A comparative analysis with British female population indicated significant differences in majority of the body dimensions.

A study by Bolstand *et al.* (2001) on anthropometry of 199 female Norwegian light industry and office workers revealed that there was no significant difference in stature between the two age groups of 20-29 year and 30-39 year female workers. Mean stature of female workers was reported as 1661mm with mean shoulder height of 1357mm and elbow height of 1024mm. Mean value for chest depth of female was recorded as 181mm and hand length of female was recorded as 177mm. Further, the study indicated 50^{th} percentile value of stature of Norway female as 1661mm and hand length as 177mm. The corresponding values for North Europe female were 1690mm and 175mm.

An investigation was undertaken by Kumar and Parwati (2001) to estimate the energy expenditure of rural women involved in dry farming operations. Anthropometric parameters of 12 women engaged in dry farming operations were recorded. The variations in height observed were between 147cm and 156cm, eye height were 135 and 144cm, hand length was between 65 and 72cm and chest circumference noted was between 78 and 92.5cm This shows that the anthropometric variations are prominent among women.

Study on ergonomical evaluation of drudgery prone farm activity by Borah *et al.* (2001) on 30 farm women found that the mean stature of women in the age group of 35-45 years was more (152.10cm) than the women in the age group of 25-35years. (147.21cm) though the difference was non significant. This shows that the anthropometry varies with age.

Rupesh Kumar (2001) conducted study on 13 professional cleaners and analysed cleaning process with special reference to cleaning tools it was observed from the study that the mean height of cleaner was 163cm in the range of 150-180 cm.

Anthropometric survey among 100 farmers from Arunachal Pradesh engaged in Jhum cultivation in the age range of 18-60 years was conducted by Dewangan and Datta (2001). It was clear from the study that mean stature of farmers was 162.08cm in the range of 146.50-175.9cm, eye height was 150.42cm in the range of 135.30-163.60cm, acromial height was 135.50cm in the range of 124.30-147.20cm, elbow height was 117.33cm in the range of 92-112cm Chest circumference and waist circumference noted were 87.71cm and 77.38cm respectively. Span and span akimbo noted were 167.86 and 86.03cm, hand length and palm length was 17.66cm and 9.90cm respectively. It appeared from the study that the Jhum cultivators of Arunachal Pradesh were at par in stature with the agricultural workers of Central India. The Acromial height and elbow height of Jhum Cultivators of Arunachal Pradesh was more than the Agricultural workers of Central India whereas, hand length, palm length and span of Jhum cultivators was smaller than the measurements of Agricultural workers from Central India.

Dhara *et al.* (2001) conducted anthropometric survey among 404 agricultural workers in the range of 18-75 years. It was found that mean stature of the worker was 154.7cm with fifth percentile of 140.79 and ninety-fifth percentile of 168.69cm Mean shoulder height and elbow height was noted as 127.5cm with fifth and ninety-fifth percentile of 115.58cm and 139.44cm and 95cm with fifth and ninety-fifth percentile of 86.02 and104.01cm respectively. Hand length was observed as 16.8cm with fifth and ninety-fifth percentile value of 15.07 and 18.52cm respectively.

A study conducted by Singh *et al.* (2004) among 120 randomly selected women farmers from Kumaon hill indicated that normal standing height of women was 151cm in the range of 145-162cm, eye height was 146cm in the range of 139-156cm, mid-shoulder height was 134 cm in the range of 128-141cm, acromion height was 132 cm in the range of 126-138cm, elbow height was 96cm in the range of 91-102cm, abdominal extension height was 99 cm in the range of 95-105cm and waist height was 92 cm in the range of 84-96cm. Span and Span akimbo reported was 148cm and 75cm in the respective ranges of 132-158cm and 66-100cm. Maximum body breadth was noted as 48cm in the range of 37-70cm, waist circumference was in the range of 56.98cm with mean value of 76cm. Hand length and palm length of women was recorded as 16cm and 8cm with corresponding ranges of 12-18 and 6-7cm. Normal squatting height was 78cm and mid-shoulder height in squatting position was noted as 60 cm. It was found that the range of majority of the static anthropometric dimensions was wide among female from the same region.

Hsiao *et al.* (2002) studied the anthropometric differences among occupational groups of both males and females in U.S.A. The findings revealed that body size or body segment measurements of some occupational group differed significantly. Among the different occupations it was found that Agricultural workers were shorter by an average of 2.5cm in height and had wider wrist breadth than other workers. Female agricultural and manufacturing workers had larger waist circumferences than those in the other occupations. Protective service workers were taller and heavier than those in all occupations combined. Further, it was found that differences in age and race distributions among occupations might be confounding contributing factors to the differences seen in anthropometric variables between occupations.

Pennathur and Dowling (2003) studied anthropometry of old (60-65 yrs) and young (20-29yrs) Mexican American women and assessed the effect of age on anthropometry. It was found that the young Mexican women were taller (161.36cm) than older Mexican women (152.57cm). This indicated that younger generation was having larger dimensions than older generation.

Cheng *et al.* (2004) compared the anthropometric data from four East Asian countries. It was observed from the study that Korean female was taller (1588mm) having more eye height (1480mm) and shoulder height (1289mm) followed by Taiwanese female who were having height of 1573mm, eye height of 1457mm and shoulder height of 1285mm. Chinese female and Japanese female were at par with respect to height (1570 and 1569mm) and shoulder height (1271 and 1270mm) with each other whereas, the average eye height of Japanese women was lower (1448mm) than the eye height of Chinese women (1454mm). Elbow height noted for Taiwanese (1007mm) was higher than Chinese (987mm) and Japanese female (983mm). The mean fingertip height recorded for Taiwanese female was higher (620mm) than Japanese (611mm) and Korean female (604mm). Thus, it can be concluded that there was a significant ethnic diversity and morphological difference among the female in the same region. The main land Chinese body shape has a narrower body with mid range limbs. The Japanese body shape was wider with shorter limbs. The Korean body shape was mid range among the four people but the upper limbs were longer. The Taiwanese body shape has wide shoulder and narrow hip with large hands and long legs.

Karunanidhi *et al.* (2004) studied anthropometry of 100 male and female farm workers between the age group of 26 and 48 years. It was noticed from the study that the female farm workers were having significantly lower dimensions for anthropometry like standing height (1508mm), eye height (1361mm), elbow to finger tip length (399mm) and hand length (173mm) than that of male farm workers. This indicates the gender variation in anthropometric measurements of farm workers and focuses the necessity for designing the farm machinery and implements separately for male and female workers.

Bylund and Burstrom (2006) evaluated the effect of gender, handle size and vibration level on the ability to perform precision task by surveying 20 men and 20 women. It was clear from his study that the body height (167cm) and hand length (16.1cm) of female subject was significantly lower than that of body height (180 cm) and hand length (17.8 cm) of male subjects so as to affect the maximum grip strength of female (350N) and male (555N). Results thus indicated that there should be consideration to gender differences in the design of machines and tools.

It can be inferred from the above-cited studies that a wide variation is observed in different static anthropometric measurements of women. It is also clear that certain factors like age, gender, occupation, and ethnic group, geographic location of subjects, etc. invariably affected the static anthropometric measurements of women. The effect of above factors was more pronounced and significant in case of age, gender and geographic location. The women of younger generation were having larger anthropometric dimensions than the women of older generation. Ethnic diversity in the selected anthropometric measurements was found to be wider revealing a vast difference in the measurements of women of different countries and within India. As there is a wide variation in the static measurements between the women of different region it is essential to collect the data pertinent to the region and user group for further application in the field of ergonomics.

2.2 Dynamic Anthropometry of Women

Dynamic anthropometry deals with compound measurements of the moving human being, which consists of reach measurements and angular ranges of various joints. Dynamic dimensions are taken under conditions in which the body is engaged in some physical activity. The majority of the anthropometric data available is limited to static measures. Conspicuous by their absence are the data on dynamic measures. Functional measures are more representative of actual human activity and answer to many design problems come from measures of the body in motion. Dynamic anthropometric measurements describe the functional limits for ability of person to do the job and helps in establishing functional work spaces.

Fluegel *et al.* (1986) had collected anthropometric data of East German adults aged between 18-59 years and observed that the 90 per cent of women were having vertical grip reach between 1843mm and 2103mm whereas, the forward grip reach noticed was 650-767mm. These measurements were lower than the male adults.

A study conducted among 4960 Egyptian women by Moustafa *et al.* (1987) indicated that mean vertical arm reach of women was higher in the age group of 31-40years (202.3cm) followed by the age group of 20-30years (199cm). A similar trend was noticed for forward arm reach of women i.e. 88cm in the age group of 31-40years and 81cm in the age group of 20-30years. The functional measurements declined after the age of 41 years. Thus, it was observed that the age negatively affected the functional anthropometry of women after 40 years.

Boussena and Davies (1987) studied engineering anthropometry of 25 female clients of employment rehabilitation centre. Arm reach recorded was 591 mm with deviation of 23.7mm and fifth percentile value of 552mm and ninety-fifth percentile value of 630mm. Arm reach of Employment Rehabilitation Centre clients when compared with the arm reach of able bodied group exhibited a non significant difference.

Varghese *et al.* (1989) recorded the anthropometric measurements of 120 non-pregnant and non-lactating women between the age ranges of 21-50 years residing in Mumbai. It was observed from the study that the functional reach of women was 71.9cm, maximum arm reach was 79.2cm and overhead grasp reach was 188.9cm The corresponding values of fifth and ninety-fifth percentile were recorded as 65.1 and 79.2cm; 72.5 and 86.8cm and 174.1 and 201.6cm .The data was further compared with the data collected by Nag (1986), Ray *et al.* (1983) and Eveleth and Tanner (1976) and found that there was wide variation in range measurements of women from different population groups.

Kroemer (1989) reported the U.S. civilian data on body dimensions of females in the age group of 20-60 years. It was indicated that female from U.S. were having forward functional reach within the range of 64 and 79 cm, which was significantly, lower than the forward functional reach recorded for male members, which was within the range of 76.3 and 88.3cm. This indicated that gender of the subject affected the functional measurements of body.

Gite and Yadav (1989) surveyed 39 farm workers and studied 52 body dimensions necessary for the design of farm machinery. It was reported that Mean vertical reach and vertical grip reach of farmers was 210.7cm and 199.3cm in the corresponding ranges of 195.4-226.7cm and 184.3-214.7cm Arm reach from wall was noticed to be 83.1cm in the range of 77.1-92.8cm and recorded the variations in dynamic anthropometry of women.

Gorden *et al.* (1989) measured and reported anthropometric data of US adults between the age group of 19-60 years. It was observed that the ninety-fifth percentile for vertical grip reach and forward grip reach of US female was 2094mm and 1296mm respectively which were lower than the vertical grip reach (2260mm) and forward grip reach (1401mm) of US male.

Mebarki and Davies (1990) conducted a survey among 666 Algerian females in the age group of 16-65 yrs. and noted their mean horizontal forward reach as 720 mm in the range of 548-979 mm. and mean vertical reach was recorded as 1888 mm in the range of 1037-2188 mm. The fifth and ninety-fifth percentile values for horizontal forward reach and vertical reach indicated that 90 per cent females were having horizontal forward reach within the range of 610 mm-828mm and vertical reach within the range of 1708 mm-2068mm. The functional measurements of Algerian female were noted to be varying with age, occupation and geographical region.

Gite and Chatterjee (1991) while reporting the anthropometric data of all India female agricultural workers reported vertical reach of women as 193.48cm in the range of 157.40-217.20, vertical grip reach as 184.45cm in the range of 165-207cm, arm reach from wall as 77.80cm in the range of 66.10-89.00 and thumb tip reach as 72.26cm in the range of 64.00-83.70cm Wide range was noticed in the selected dynamic anthropometry of female agricultural workers from all over India.

Study conducted by Loganayaki and Saramma (1992) among 300 homemakers indicated maximum reaching height for selected homemakers in vertical plane was 188.7cm and maximum comfortable height was 160cm Comfortable and minimum reach measurements in vertical plane were 125.7cm and 69.1cm respectively. The corresponding values for maximum reaching height and comfortable reach in horizontal plane were 56.8 cm and 33.8 cm.

Pheasant (1996) reported anthropometric data of British adults between the age group of 19-35 years. The fifth and ninety-fifth percentile values indicated that the 90 per cent of female were having vertical grip reach between 1790-2020mm and forward grip reach between 650-755mm. The measurements recorded were lower than that of male members surveyed.

Mououdi (1997) studied anthropometric measurements of 105 male and 74 female students from Teharan University and reported average arm reach of female student from wall as 76.68cm within the range of 69-84.60cm which was found to be lower than that of male students which was 85.57cm within the range of 73.20-96.50cm Thus, it indicates that the functional anthropometry varies with the gender.

Botha and Bridger (1998) studied 100 full time nurses in Western Cape and recorded selected anthropometric measurements. Mean grip reach of nurses working in the Western Cape was noted to be 689mm in the range of 531mm – 811mm. It is thus clear from these values that the variation of mean grip reach is so wide that it is impossible to have common design solution of workplace.

Report given by Wang *et al.* (1999) after measuring 735 male workers and 465 female workers from Taiwan's Main industries indicated Functional forward reach and functional overhead reach of female workers as 754.4 and 1925.9mm respectively which was lower than the functional forward reach (822.4mm) and functional overhead reach (2103.1mm) of male workers. This indicates that the gender and static measurements have impact on functional anthropometry of workers.

Study was conducted among 6000 women from different zones in India reported by Verma and Oberoi (2000). It was observed that Vertical normal reach reported for Ludhiana women was more (168.05cm) than the women from Hisar (133.29cm), Hyderabad (163.45cm), Udaipur (137.02cm), Pantnagar (142cm) and Dharwad (132.98cm). Vertical Maximum reach of women from Hisar (193.73cm) was more than the measurements of women from Ludhiana (170.30cm), Hyderabad (169.47cm), Udaipur (187.42cm), Pantnagar (178cm), and Dharwad (177.51cm). Thus, it is concluded that the functional measurements vary in women from different zones in India.

A study by Bolstand *et al.* (2001) revealed that Mean grip reach of Norway female was reported as 686mm with 629mm as fifth percentile and 743mm as ninety-fifth percentile. There was not significant variation between the mean grip reach of female in the age group 20-29 years and 30-39 years which indicates that much of the variation in dynamic anthropometry do not occur within the age range of 20-39 years.

Dewangan and Dutta (2001) conducted anthropometric survey on 100 farmers engaged in Jhum cultivation in Arunachal Pradesh and found that the vertical reach was 203.03cm in the range of 181.40-2260.cm, vertical grip reach as 197.00cm in the range of 176.50-219.80cm, arm reach from wall was 80.79cm in the range of 71.50-91.10cm and Thumb tip reach was 74.96cm in the range of 61.80-83.60cm These functional measurements of Jhum cultivators when compared with the measurements of Agricultural workers of Central India it was found that

Jhum cultivators were having lower vertical reach, vertical grip reach, arm reach from wall and thumb tip reach than that of the agricultural workers of Central India.

A study conducted by Singh *et al.* (2004) among 120 randomly selected women farmers from Kumaon hill indicated that Vertical upward arm reach noted for women was 200 cm in the range of 184-223cm, mid position height was 112cm in the range of 77-151cm and lower position forward height was 12 cm in the range of 11-16cm Vertical arm reach in squatting posture was 135cm in the range of 105-143cmWide variation was noticed in dynamic measurements of women.

Pennathur and Dowling (2003) studied anthropometry of older and younger Mexican American women and observed that the vertical finger tip reach (199.52cm) and vertical grip reach (170.8cm) of younger Mexican women was more than the vertical finger tip reach (180.69cm) and vertical grip reach (167.41cm) of older Mexican women. It was thus, found that the changes in anthropometry do take place in old age.

The study conducted by Cheng *et al.* (2004) compared the anthropometric data from four Asian countries and noted the mean values for horizontal finger tip reach for Taiwanese female as 757mm, Japanese female as 751mm and Korean female as 760mm. The vertical fingertip reach of Taiwanese female was 1940mm, Japanese female was 1928mm and Korean female was 1961mm. This indicated that there was an ethnic diversity in dynamic measurements of female and need to be considered in planning space or designing equipment.

Karunanidhi *et al.* (2004) studied anthropometry of 100 male and female farm workers between the age group of 26 and 48 years. The study indicated that the forward reach of female workers (741mm) was significantly lower ($t=36.98^{**}$) than the forward reach of male farm workers (832mm). This clearly shows that the dynamic anthropometric measurements vary from male to female Hence, the gender of the worker need to be considered while planning work areas.

It is apparent from the studies reviewed under the head of dynamic anthropometric measurements that age and gender difference, ethnic diversity, morphological differences and geographical location were more pronounced factors in determining the variations in functional measurements of women. The functional measurements are very important in determining the area of work surface and it needs to be given priority while planning the dimensions of work surface and equipment. The dynamic anthropometric measurements not only varied among women of different countries but also varied in different zones of India. It is also clear that little variation takes place in old age in the functional anthropometry and static anthropometrical measurements had an impact on dynamic measurements of women.

2.3 Statistical Implications Regarding Anthropometry of Women

Statistics is the science, which deals with designing of experiments and analysing the data. Statistical implications interpret the analysed data and helps in presenting numerical facts.

Shahnawaz and Davis in 1977 studied the correlation and regression between various vertical distances in standing position through anthropometric survey among 400 Iranian steel workers between the age group of 20-60 years. Findings of the study indicated that stature was positively correlated with eye height ($r=0.97^{**}$); shoulder height ($r=0.93^{**}$); elbow height ($r=0.80^{**}$); hip height

($r=0.86^{**}$) with respective regression equations of $\hat{Y}=0.97x+13.56$; $\hat{Y}=1.00x+29.11$; $\hat{Y}=1.04x+60.16$ and $\hat{Y}=1.14x+51.35$. Similarly eye height was having positive correlation with shoulder height ($r=0.92^{**}$); elbow height ($r=0.79^{**}$) and hip height ($r=0.86^{**}$). Corresponding regression equations reported were $\hat{Y}=0.98x+22.09$, $\hat{Y}=1.02x+52.01$ and $\hat{Y}=1.12x+43.12$. Shoulder height revealed positive significant correlation with elbow height ($r=0.79^{**}$) and hip height ($r=0.86^{**}$). The regression equation of shoulder height with elbow height and Hip height were $\hat{Y}=0.95x+41.54$ and $\hat{Y}=1.05x+32.49$ respectively. Study further, indicated significant positive correlation between elbow height and hip height ($r=0.73^{**}$) with regression function as $\hat{Y}=0.75x+27.51$. This indicated that the static human body dimensions are related significantly with each other.

Hutchinson (1980) studied anthropometric measurements of 416 female drivers and results revealed that distinction between the length and breadth/ depth measurements is clearer in the group of female than for males. The correlations within the group of breadth and depth measurements were slightly higher and those between length and breadth/depth were lower in females than for males. This indicated gender effect on anthropometry. Partial correlation coefficients reported between stature and eye height of female was 0.67; stature and shoulder height of female was 0.61 and stature and buttock height of female was 0.65, which indicated significant correlation of stature with eye height, shoulder height and buttock height.

Kroemer (1989) analysed 5 U.S. Anthropometric Survey by applying correlation coefficient and reported high positive correlation of stature and waist height with standing acromion height ($p< 0.01$), thumb tip Reach ($p<0.05$) and hand length ($p<0.05$). This indicated that Stature and waist height contributes to shoulder height, thumb tip reach and hand length of body.

Study conducted by Yang and Liang (1990) among 18 female adult subjects showed that the body height was correlated with shoulder height and elbow height of the worker.

Sumangala (1995) in the study through stepwise multiple regression analysis had reported that elbow height contributed to a greater extent for the estimation of maximum horizontal reach.

Correlation between anthropometric traits and body posture traits have been studied among females performing a task with predominance of static load in the sitting and standing position by Ryszard during the year 1996. Findings of the study indicated correlations higher than 0.7 between anthropometrical traits in 19.6 per cent females in standing position. Among the anthropometrical traits the highest share in correlations higher than 0.7 was for shoulder breadth (32.1%) and sitting height (23.8%). Among body posture traits the correlations concerning arm angle in the sagittal plane (20.1%), bending of trunk in frontal plane (19.3%) and arm angle in frontal plane (17.7%) were most frequent. These three traits formed 57.1 per cent of the correlations higher than 0.7.Further, the study indicated the effect of biacromial breadth on the size of the arm angle as the wider the biacromial diameter, the greater the angle elevation of the arm forward when the hand is situated at an angle of 30 and 0 degree and the smaller when the hand is at an angle of 30 and 60 degree.

From the report of AICRP Udaipur (1996) it was obvious that the age of respondents made no difference in various Anthropometric dimensions in the standing positions viz. height, shoulder height, eye level height and elbow height.

The miscellaneous anthropometric measurements of rural women showed almost no difference between the two age groups showing negligible effect of age on anthropometric measurement in various body positions.

Sumangala and Ogale (1996) observed that the mean elbow height of the respondents was 95.52-cm Elbow height; arm length and arm span had a positive significant relationship with horizontal reach of worker

Botha and Bridger (1998) studied 100 full time nurses in Western Cape and recorded selected anthropometric measurements. Values of correlation coefficients indicated significant positive correlation of stature with eye height (0.95), shoulder height (0.95) elbow height (0.9), hip height (0.82) and hand length (0.32) whereas, palm length and stature was not having correlation with each other (0.10). Further, it was clear from the study that grip reach of nurses was positively and significantly correlated with stature (0.37), eye height (0.31), shoulder height (0.32) and elbow height (0.26). It can be concluded from the study that majority of the static dimensions are related with each other.

Liu *et al.* (1999) analysed the anthropometric data of 110 female operators in Maquiladora plant in the age group of 17-39 and indicated the significant correlation of eye height ($r=0.891^{**}$), elbow height ($r=0.828^{**}$), elbow to middle finger distance ($r=0.733^{**}$), hand length ($r=0.591^{**}$) and biacromial distance ($r=0.37^{**}$) with stature of female. Thus, it indicated that the body stature affect much of the vertical static dimensions of female.

Chaffin *et al.* (2000) surveyed 18 female drivers and 20 male drivers and observed that stature had a significant effect on some of the far side and overhead reaches but less effect on the forward reaches to the target destination. When reaching to the far targets located to the side taller people had to use far less trunk lateral bending i.e. 6 degree less per 10 cm of height and shoulder vertical angle about 10^0/10 cm than did shorter individuals. Increased stature also had a profound effect on the amount of shoulder vertical abduction and elbow flexion angle (about 10^0/10cm) when reaching to the overhead destination. Thus, it can be said that Stature and age have a larger effect than does gender on reach motion postures for motions chosen by the participants while reaching to targets placed throughout a typical automobile interior.

Karunanidhi *et al.* (2004) studied anthropometry of 100 male and female farm workers between the age group of 26 and 48 years. Mathematical modeling of the body dimensions was done to establish the relationship between standing height and other body dimensions. It was observed that there was significant relationship between the standing height and eye height (R^2=0.81**) and standing forward reach (R^2= 0.34**). The prediction models for eye height and forward reach were $\hat{Y}=1112.9+10.55e^{x/447.3}$ and $\hat{Y}=635.1+6.03e^{x/479.5}$ respectively. Thus, it was clear from these models that standing height could predict eye height and forward reach of the worker.

Report given by Kathirwel (2005) after collecting anthropometric measurements from 587 female farm workers from 7 agro climatic zones of Tamilnadu indicated the average stature of women as 150.07cm in the range of 133-165cm Regression equations were depicted through the study as $(\text{Vertical reach})^{0.5}=11.6+6.4e^{-07}(\text{stature})^3$; eye height = $63.17+0.0033(\text{stature})^2$; Knee height + $26.221+ 0.00079(\text{Stature})^2$; Thumb tip reach= $85.68+(-0.94515^{*}718/(\text{arm reach from floor})^2)$ and palm length = $6.26+0.000659/\text{hand length}^3$. This indicated that stature can be a predictor for determining vertical reach, eye height and knee height whereas, thumb tip reach can be determined by arm reach from floor and hand length can assess palm length of female.

It can be concluded from the above-cited studies that statistical implications are proven for the various static and dynamic anthropometric measurements. Static body dimensions were significantly related with each other. It is also evident that stature of women exerted a significant impact on the other static anthropometric measurements of women.

MATERIALS AND METHOD

The present study entitled "Statistical modeling of relationship between static and dynamic anthropometry of women" was planned with the objective to measure the static and dynamic anthropometry of women and assess the relationship between static and dynamic anthropometry.

To achieve the planned objectives for the present study, a systematically designed plan of work was carried out. The detailed sequential procedure followed for assessing the static and dynamic anthropometry of women is organized along with the relevant details under the following sections

3.1 Locale of Study

3.2 Sample Selection

3.3 Pilot Study

3.4 Development of Tool

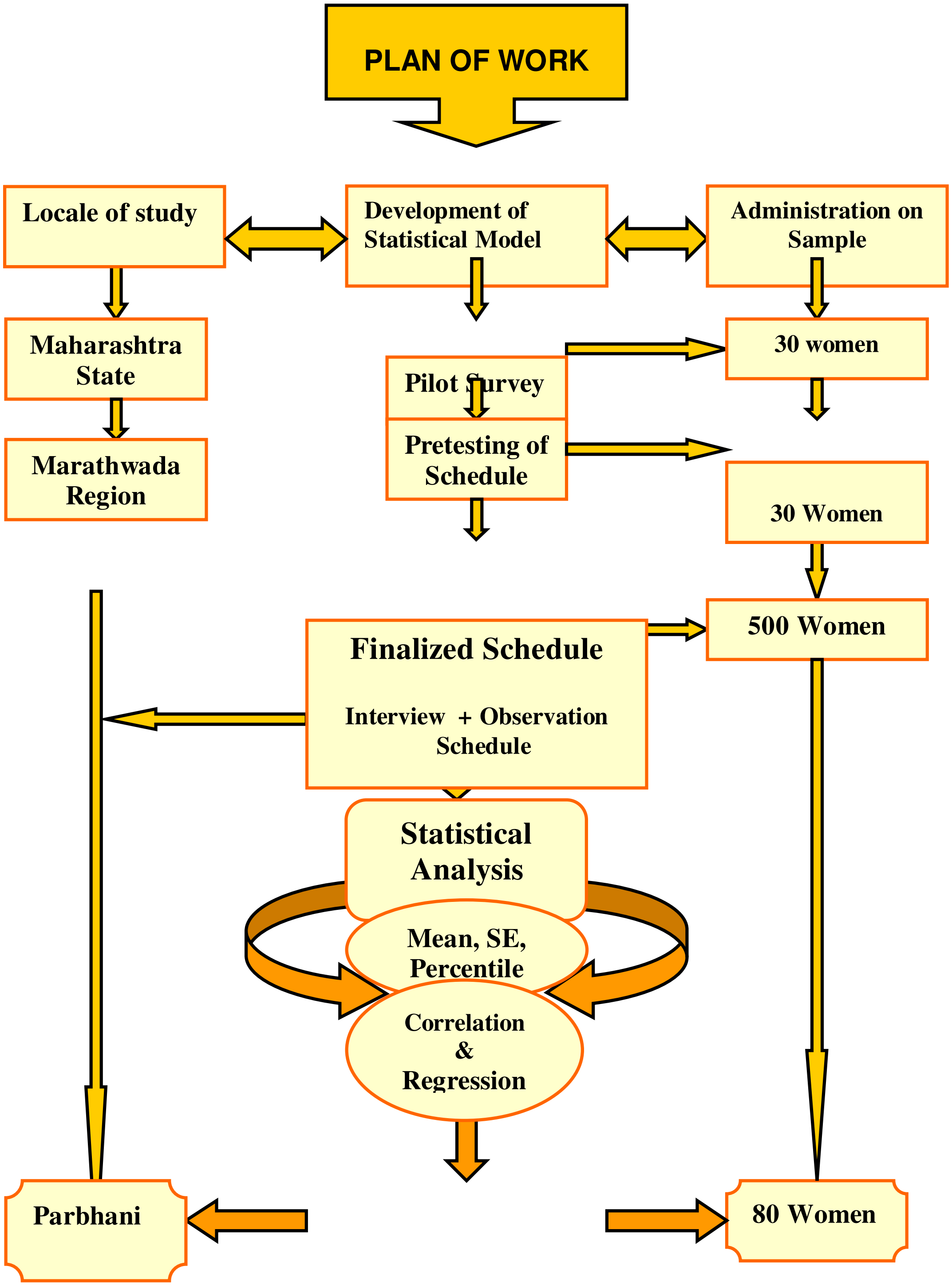
3.5 Method of Data Collection

3.6 Setting Hypothesis

3.7 Analysis Strategy

3.1 Locale of Study

The nature of the present study required close observation of the respondents and recording of data was expected to extend over a long period there by the investigator was supposed to engage the respondent for longer period for recording measurements. The rapport with the community was an important consideration from the point of co-operation from respondents; hence, the study was restricted to Parbhani city, which consists of all community in clusters.


PLAN OF WORK
Locale of study
Development of Statistical Model
Administration on Sample
Maharashtra State
30 women
Pilot Survey
Pretesting of Schedule
Marathwada Region
30 Women
500 Women
Finalized Schedule
Interview + Observation Schedule
Statistical Analysis
Mean, SE, Percentile
Correlation & Regression
Parbhani
80 Women

Plan of work

3.2 Sample Selection

A Sample for any study represents population and study carried out on specified group help to draw general inferences. A sample for present study comprised women population. A major anthropometric concern in space design is the statistical description of all those persons who may be involved in its operation. This group of persons is defined as the total user population. It is usually impossible to measure every individual in a population; therefore, a smaller group called sample is selected for the study. Size of sample is an important problem to be decided in case of sampling. According to Parten "an optimum sample in survey is one which fulfils the requirement of efficiency, representative ness, reliability and flexibility. In general, sample should be large enough to avoid intolerable sampling error but for technical study, which requires long time, large sample is unfit (Bajpai, 1976). Considering the nature and technicality of the problem sample size was decided for the study. A sample of 30 homemakers each was selected randomly for pilot study and pretesting of developed schedule. Sample of 500 women from the age group of 25 to 45 years of age was selected by purposive random sampling technique to assess the relationship of static and dynamic anthropometry of women. Purposive selection deliberately selects certain units for study from the universe. The sample for testing the derived statistical relationship comprised 80 homemakers from the age group of 25 to 45 years exclusive of surveyed sample of 500 women.

3.3 Pilot Study

A pilot study is necessary for successful planning of research. A pilot study is a small-scale test using exact procedures planned for the larger study. A pilot study is the preliminary study of the universe in question to get an early idea about it. A pilot study is undertaken before a schedule or questionnaire is drafted. It will bring the researcher face to face with realities and may pose problems, which had not been thought of and help to think the causative factors in advance. It gives an idea of different variables involved, nature of the problem, possible difficulties in interviewing and kind of response likely to be available. According to Bajpai (1976) after theoretical preparation has been made some sort of trial survey is necessary to gain specific knowledge of the study and necessary amendments can be made in questionnaire or schedule before finalizing it. Thus, the pilot study not only helps to refine the instrument but also assists in training the interviewer. Hence, a pilot study with 30 well-experienced homemakers was conducted to find out the posture adopted while performing household tasks. Based on the findings of pilot study the two commonly used postures for performing household tasks were selected for inclusion in the final observation schedule.

3.4 Development of Tool

3.4.1 Preparation of Schedule

A schedule is a form containing some questions relevant to the topic of study or blank Table, which are to be filled in by the observer after getting the information from respondent. The purpose of schedule is to provide a standardized tool for observation or interview in order to attain objectivity. Thus, it can be used as an objectifying device for observation. The schedule prepared for conducting present investigation comprised both the Interview schedule and Observation schedule.

3.4.1.1 Interview Schedule

An Interview schedule contains standard questions that the interviewer has to ask keeping in view the objectives of the study and different types of information to be collected. The interview schedule comprised questions to elicit the information regarding demographic profile of family including their personal background information such as age, education, income of family, family size, family type etc.

3.4.1.2 Observation Schedule

An observation Schedule is used for observation purposes. It contains specific topics upon which the observer has to concentrate and the nature of information that he has to record. Such schedules make observation more pointed and accurate by pointing clearly what is to be observed.

In order to get authentic information a descriptive, self explanatory and illustrative observation schedule was prepared to record the selected measurements of static and dynamic anthropometry of women. Observation schedule prepared for the study included 23 static measurements in standing posture and 11 static measurements in squatting posture. Total dynamic measurements included in observation schedule were 26 and 12 in standing and squatting posture respectively.

3.4.2 Pretesting of Schedule

Pretesting an instrument is a means of evaluating its efficacy before using it in the final study. The pretest is usually conducted on a small group in an interactive manner. Its goal is to determine if the questionnaire is clear, understandable and contains important elements as viewed from the subject's perspective. Some of the errors can be found out only when the schedule has been actually put into operation. The prepared schedule was pretested on 30 randomly selected women.

3.4.3 Development of Final Tool

After the pilot study and pretesting the schedule required amendments were made in the interview and observation schedule in the light of experience gathered and were finalized. (Appendix I)

3.4.4 Administration of Tool

Finalized interview and observation schedule were administered to 500 randomly selected women having age between 25-45 years.

3.5 Method of Data Collection

A participant observation method was adopted for collection of data. It is a controlled observation, which affords greater precision and objectivity and can be repeatedly observed under identical conditions. Thus, it is a simplest method for greater accuracy and more convincing results. (Bajpai, 1976)

The descriptive data were gathered personally by using the interview schedule. A visit was made by the investigator prior to data collection in order to establish rapport with respondents to ensure full confidence and cooperation from the respondents. For experimental data the Anthropometric measurements of the respondents were measured by using direct method. Observations were recorded by a trained observer in natural setting and in experimental postures in observation schedule.

3.5.1 Recording of Anthropometric Measurements

Anthropometric measurements serve as basic population descriptors and are applied in the design of workspaces and the physical environment as well as the sizing of personal items and equipment. The group of measurements is made up of simple point-to-point distances in one or another of the principal body axes and some geometrically more complex circumferences and surface contours. They are typically obtained manually using an anthropometer, a variety of special calipers and flexible measuring tape. Investigator had measured these variables personally with the help of appropriate tools. (Plate 1)

3.5.1.1 Anthropometer

Anthropometer is a precision instrument consisting a vertical graduated rod made up of four inter-connecting sections of tubular metal that are engraved in millimeter intervals. The heights were noted by using a movable slide housing that contains an adjustable perpendicular blade, which is placed in alignment with or lightly on the desired measuring point. The model was capable of measuring stature or other heights from the floor and seated surfaces up to 210 cm when completely assembled. The heights were noted by using a movable slide housing that contains an adjustable perpendicular blade, which is placed in alignment with or lightly on the desired measuring point.

3.5.1.2 Beam/Sliding Caliper

The two upper sections of the Anthropometer may be used as a beam caliper as they were equipped with a millimeter scale on the side opposite the main scale that starts with zero mm at the top fixture. The beam caliper, which was capable of measuring distances up to 95 cm, is used for measuring whole body depth and breadth as well as many straight linear distances between landmark points.

3.5.1.3 Flexible Measuring Tape

Body circumferences of the respondents were measured with the flexible measuring tape.

3.5.2 Variables of Measurement

A concept that can take different quantitative values is called a variable. If one variable depends on other variable or consequences of other variables are termed as dependant variables. The variable, which is antecedent to the dependant variable, is termed as independent variable. The list of dependent and independent variables is presented below.

All the variables of measurement in dynamic anthropometry were considered as dependant variables and independent variables were all static measurements of women in standing and squatting position. Standard terminologies as given by Chakrabarti (1997) have been used.

3.5.2.1 List of The Dependent Variables Studied in Present Investigation

Sr. No.	Anthropometric Measurement	Termed as
A)	**Dynamic Anthropometry in Standing Posture**	D
1	Vertical Upward Arm Reach	D_1
2	Vertical Upward Grasp Reach	D_2
3	Upper Position Arm Reach Length	D_3
4	Mid Position Arm Reach Length	D_4
5	Lower Position Arm Reach Length	D_5
6	Upper Position Arm Reach Height	D_6
7	Mid Position Arm Reach Height	D_7
8	Lower Position Arm Reach Height	D_8
9	Upper Position Grasp Reach Height	D_9
10	Mid Position Grasp Reach Height	D_{10}
11	Lower Position Grasp Reach Height	D_{11}
12	Upper Position Grasp Reach Length	D_{12}
13	Mid Position Grasp Reach Length	D_{13}

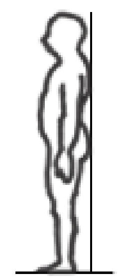
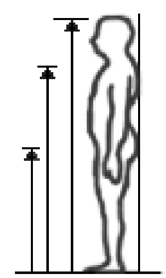
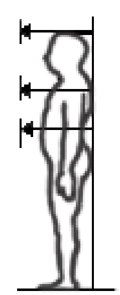
Sr. No.	Anthropometric Measurement	Termed as
14	Lower Position Grasp Reach Length	D_{14}
15	Forward Upper Position Arm Reach Length	D_{15}
16	Forward Mid Position Arm Reach Length	D_{16}
17	Forward Lower Position Arm Reach Length	D_{17}
18	Forward Upper Position Arm Reach Height	D_{18}
19	Forward Mid Position Arm Reach Height	D_{19}
20	Forward Lower Position Arm Reach Height	D_{20}
21	Forward Upper Position Grasp Reach Length	D_{21}
22	Forward Mid Position Grasp Reach Length	D_{22}
23	Forward Lower Position Grasp Reach Length	D_{23}
24	Forward Upper Position Grasp Reach Height	D_{24}
25	Forward Mid Position Grasp Reach Height	D_{25}
26	Forward Lower Position Grasp Reach Height	D_{26}
B)	**Dynamic Anthropometry in Squatting Posture**	
1	Vertical Arm Reach	D_{27}
2	Vertical Grasp Reach	D_{28}
3	Upper Position Arm Reach Length	D_{29}
4	Mid Position Arm Reach Length	D_{30}
5	Lower Position Arm Reach Length	D_{31}
6	Upper Position Arm Reach Height	D_{32}
7	Mid Position Arm Reach Height	D_{33}
8	Upper Position Grasp Reach Length	D_{34}
9	Mid Position Grasp Reach Length	D_{35}
10	Lower Position Grasp Reach Length	D_{36}
11	Upper Position Grasp Reach Height	D_{37}
12	Mid Position Grasp Reach Height	D_{38}

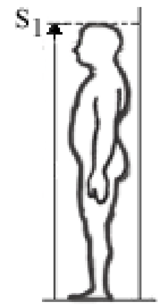
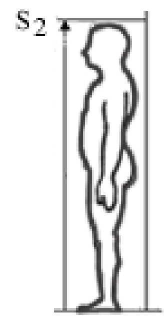
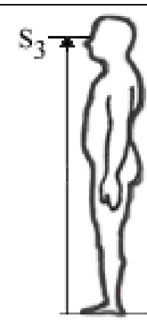
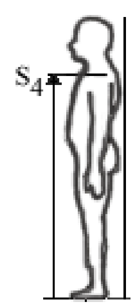
3.5.2.2 List of Independent Variables Studied in Present Investigation

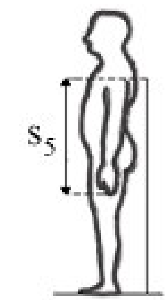
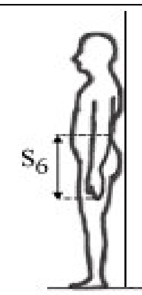
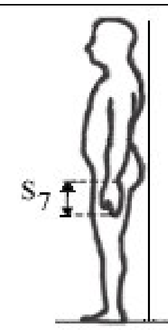
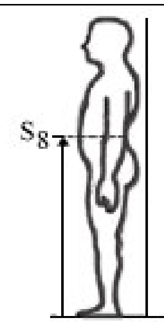
Sr. No.	Anthropometric Measurement	Termed as
A)	**Static Anthropometry in Standing Position**	
1	Normal Standing	S_1
2	Stature	S_2
3	Eye height	S_3
4	Mid-shoulder height	S_4
5	Hand Length	S_5
6	Elbow to Middle Finger	S_6
7	Palm Length	S_7
8	Elbow Height	S_8
9	Abdominal Extension Height	S_9
10	Waist Height	S_{10}
11	Buttock Extension	S_{11}
12	Tip of Radius	S_{12}
13	Tip of Middle Finger (Dactylion)	S_{13}
14	Span	S_{14}
15	Span Akimbo	S_{15}
16	Maximum Body Breadth Relaxed	S_{16}
17	Chest (Mid Tidal) Depth	S_{17}
18	Maximum Body Depth Relaxed	S_{18}
19	Chest Circumference	S_{19}
20	Circumference At Abdominal Extension	S_{20}
21	Waist Circumference	S_{21}
22	Hip Circumference at Gluteal Extension	S_{22}
23	Arm Circumference	S_{23}
B)	**Static Anthropometry in Squatting Position**	
24	Normal Squatting Height	S_{24}
25	Erect Squatting Height	S_{25}
26	Mid-Shoulder Height	S_{26}
27	Right Knee Height	S_{27}
28	Elbow to Elbow Distance Relaxed	S_{28}
29	Knee to Knee Distance Relaxed	S_{29}
30	Heel to Heel Distance Relaxed	S_{30}
31	Big Toe to Big Toe Distance Relaxed	S_{31}
32	Buttock to Knee Length	S_{32}
33	Buttock to Foot Distance	S_{33}
34	Buttock to Heel Distance	S_{34}

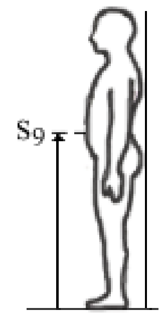
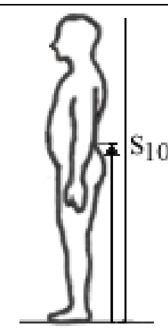
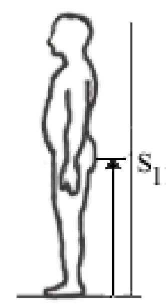
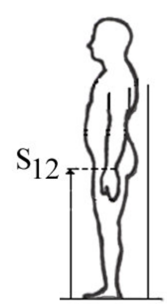
3.5.2.3 Operational Definitions of Variables of Measurements

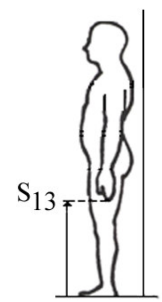
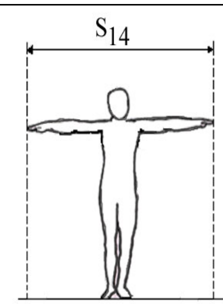
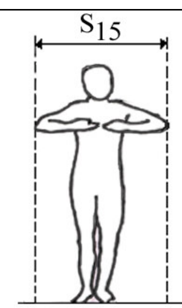
Concepts of study variables were operationally defined for accuracy in measurements. Dimensions along with their definitions and diagrammatic representation are illustrated (Chakrabarti, 1997)

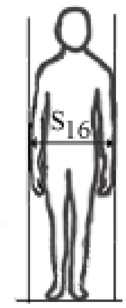
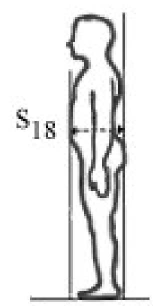
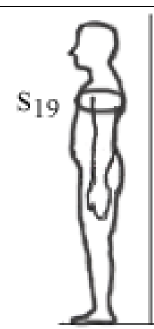
Sr. No.	Operational Definition	Illustration
1	**Standing posture**: Standing in stretched erect posture, keeping feet together and firmly placed on the ground, weight equally distributed on both feet looking straight ahead, palm flat against side of thigh.	
2	**Height**: Vertical distance from the floor to the respective points.	
3	**Length**: Horizontal distance from the wall to the respective points.	

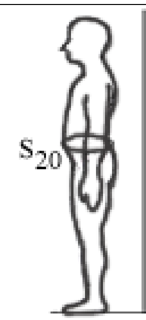
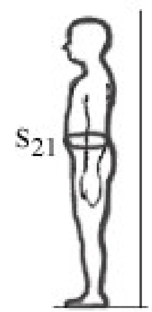
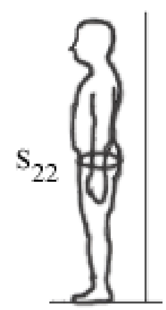
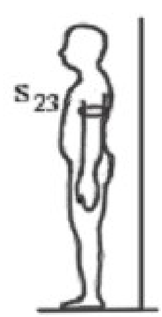
Sr. No.	Operational Definition	Illustration
4	**Normal Standing Height (S_1)**: Vertical distance from the floor to top of the head, standing in normal relaxed erect posture. (Plate 2)	
5	**Stature (S_2):** Vertical distance from the floor to top of the head, standing in erect stretched posture.	
6	**Eye Height (S_3):** Vertical distance from the floor to Inner corner of the eye.	
7	**Mid-Shoulder Height (S_4)**: Vertical distance from the floor to uppermost point on the mid-level of the shoulder.	

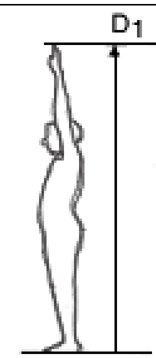
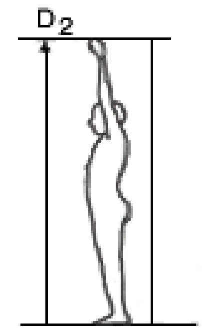
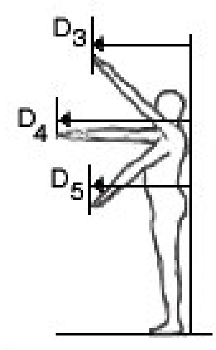
Sr. No.	Operational Definition	Illustration
8	**Hand Length (S_5)**: Distance between shoulder point and tip of middle finger.	
9	**Elbow to Middle Finger (S_6)**: Distance between proximal point of the olecranon-tip of the ulna and tip of middle finger.	
10	**Palm Length (S_7)**: Distance between Wrist point and tip of middle finger.	
11	**Elbow Height (S_8):** Vertical distance from the floor to most proximal point of the olecranon-tip of the ulna.	

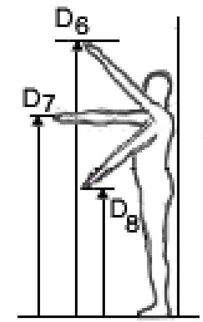
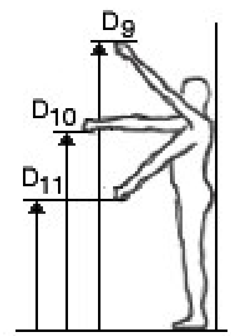
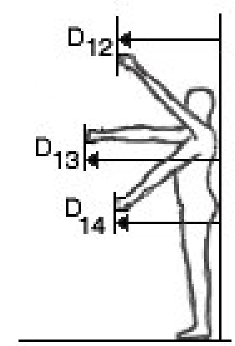
Sr. No.	Operational Definition	Illustration
12	**Abdominal Extension Height (S_9)** Vertical distance from the floor to maximum extended point of the abdomen.	
13	**Waist Height (S_{10})**: Vertical distance from the floor to upper margin of the lateral iliac crests (where the belt is worn).	
14	**Buttock Extension Height (S_{11})**: Vertical distance from the floor to maximum extended point of the buttocks.	
15	**Tip of Radius Height (S_{12}):** Vertical distance from the floor to tip of the radius (Stylion).	

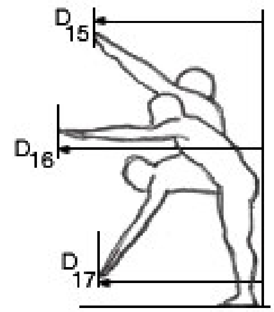
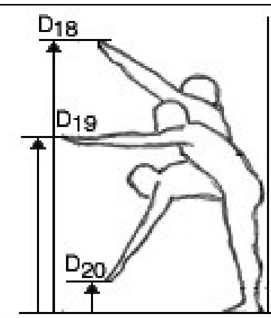
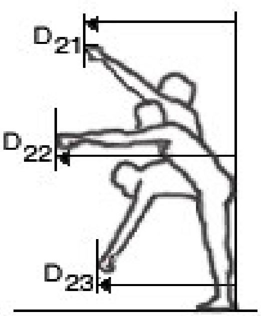
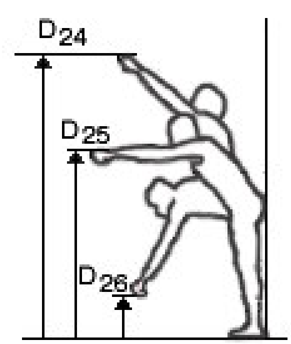
Sr. No.	Operational Definition	Illustration
16	**Dactylion Height (S_{13})**: Vertical distance from the floor to tip of the middle finger.	
17	**Span (S_{14}):** Maximum horizontal distance between the middle fingertips when both the arms are stretched out fully sideways perpendicular to the trunk.	
18	**Span Akimbo (S_{15}):** Maximum horizontal distance between the tips of the elbows when both the upper arms are stretched out sideways perpendicular to the trunk and the elbows are fully flexed so that the tips of the middle finger of both the hands touch each other.	

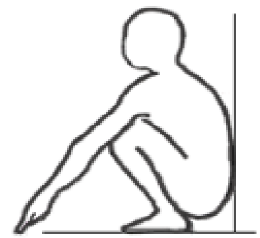
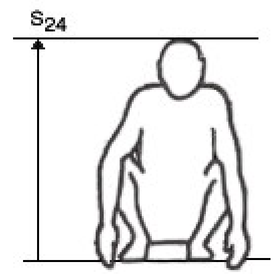
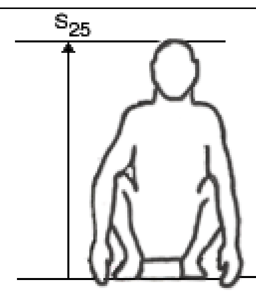
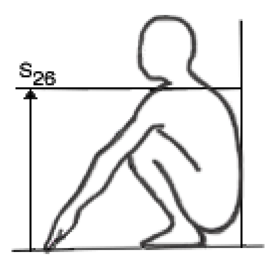
Sr. No.	Operational Definition	Illustration
19	**Maximum Body Breadth, Relaxed (S_{16}):** Maximum horizontal distance across the body including arms hanging relaxed at sides. (Plate 3)	
20	**Chest Depth (S_{17}):** Horizontal distance from the back to the front of the chest at the nipple level.	
21	**Maximum Body Depth, Relaxed (S_{18}):** Maximum horizontal distance between the vertical planes passing through the most anterior point (on the chest or abdomen) and the most posterior point (on the shoulder or buttocks) of the trunk.	
22	**Chest (Mid Tidal) on Bust (S_{19}):** Round measurement on the chest at nipple level.	

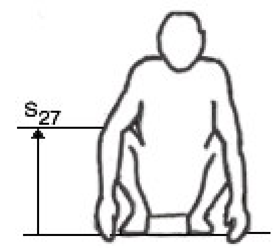
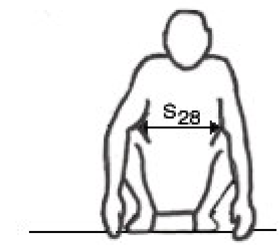
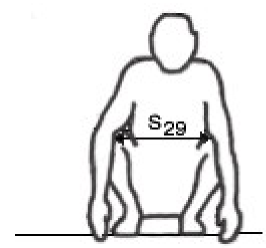
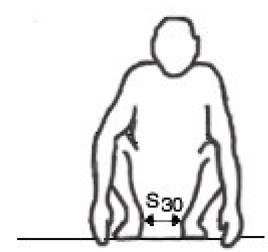
Sr. No.	Operational Definition	Illustration
23	**Abdominal Extension (S_{20}):** Round measurement on the abdomen, at its maximum extended point.	
24	**Waist Circumference (S_{21}):** Round measurement on the waist, at the level of the upper margin of the lateral iliac crests. (Plate 4)	
25	**Hip at Gluteal Extension (S_{22}):** Round measurement at the level of the maximum protrusion (gluteal extension) of the buttocks.	
26	**Arm Circumference (S_{23}):** Maximum horizontal circumference at the upper arm.	

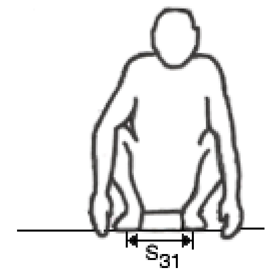
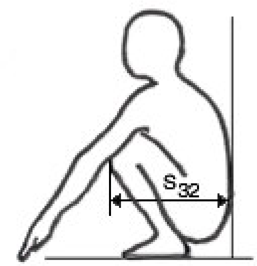
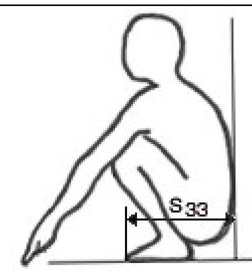
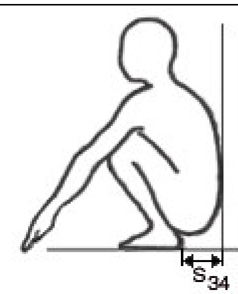
Sr. No.	Operational Definition	Illustration
27	**Vertical Upward Arm Reach (D_1):** Standing in erect posture, vertical comfortable arm reach height from floor.	
28	**Vertical Upward Grasp Reach (D_2):** Standing in erect posture, vertical comfortable grasp (center of a grasp while holding a rod of 30 mm diameter) reach height from floor.	
29	**Upper (D_3), Mid (D_4) and Lower (D_5) Position Arm Reach Length:** Standing in erect posture, high-level, mid level, low level horizontal comfortable arm reach from wall. (Plate 5)	

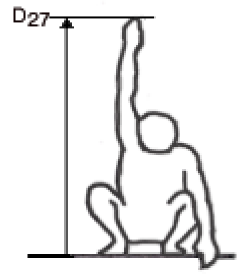
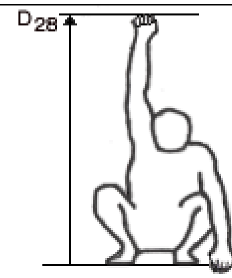
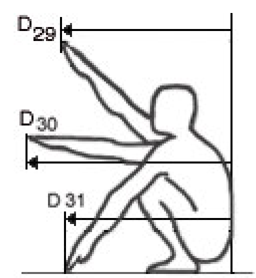
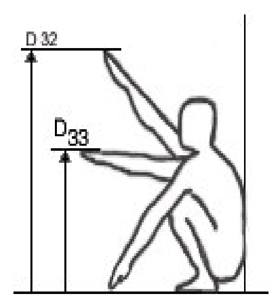
Sr. No.	Operational Definition	Illustration
30	**Upper (D_6), Mid (D_7) and Lower Position (D_8) Arm Reach Height:** Standing in erect posture, maximum vertical forward comfortable arm reach at high level, mid level and low level from floor. (Plate 6)	
31	**Upper (D_9), Mid (D_{10}) and Lower Position (D_{11}) Grasp Reach Height:** Standing in erect posture, maximum vertical forward comfortable grasp reach at high level, mid level and low level from floor.	
32	**Upper (D_{12}), Mid (D_{13}) and Lower Position (D_{14}) Grasp Reach Length:** Standing in erect posture, maximum horizontal comfortable forward grasp reach at high level, mid level and low level from wall.	

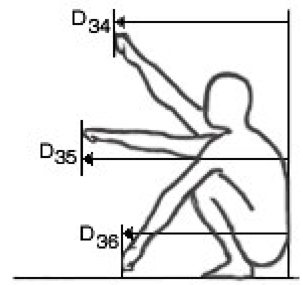
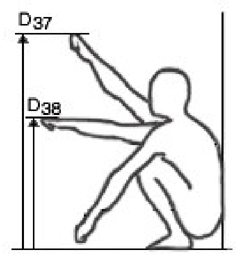
Sr. No.	Operational Definition	Illustration
33	**Forward Upper (D_{15}), Mid (D_{16}), and Lower Position (D_{17}) Arm Reach Length**: Standing in erect posture, forward comfortable higher level, mid level and low level arm reach length from wall.	
34	**Forward Upper (D_{18}), Mid (D_{19}) and Lower Position (D_{20}) Arm Reach Height:** Standing in erect posture, forward comfortable higher level, mid level and low level arm reach height from floor.	
35	**Forward Upper (D_{21}), Mid (D_{22}) and Lower Position (D_{23}) Grasp Reach Length:** Standing in erect posture, forward comfortable higher level, mid level and low level grasp reach length from wall.	
36	**Forward Upper (D_{24}), Mid (D_{25}) and Lower Position (D_{26}) Grasp Reach Height:** Standing in erect posture, forward comfortable higher level, mid level and low level grasp reach height from floor.	

Sr. No.	Operational Definition	Illustration
37	**Squatting Posture:** Subject sits erect and stretched on heels in a low position with legs drawn up closely in front of the body, weight equally distributed on both the feet, arms rested on the knees and looking straight ahead.	
38	**Normal Squatting Height (S_{24}):** Maximum vertical distance from the floor to the top of the head, while sitting comfortably in squatting posture. (Plate 7)	
39	**Erect Squatting Height (S_{25}):** Maximum vertical distance from the floor to the top of the head, in squatting erect stretched posture.	
40	**Mid-Shoulder Squatting Height (S_{26}):** Subject sitting in squatting posture maximum vertical distance from the floor to the top of the mid-shoulder.	

Sr. No.	Operational Definition	Illustration
41	**Right Knee Height (S_{27}):** Maximum vertical distance from the floor to the upper most surface of the right knee when the subject is sitting in squatting posture.	
42	**Elbow-to-Elbow Distance, Relaxed (S_{28})**: Maximum horizontal distance across the lateral surfaces of the elbows when the subject is sitting in squatting posture.	
43	**Knee-to-Knee Distance, Relaxed (S_{29}):** Maximum horizontal distance across the lateral surfaces of the knees in relaxed squatting posture.	
44	**Heel-to-Heel Distance (S_{30}):** Maximum horizontal distance across the lateral surfaces of the heels in squatting posture.	

Sr. No.	Operational Definition	Illustration
45	**Big Toe to Big Toe Distance (S_{31}):** Maximum horizontal distance between the lateral surfaces of the right and the left big toes in squatting posture.	
46	**Buttock to Knee Length (S_{32}):** Maximum horizontal distance from the rearmost point of the uncompressed buttocks to the most anterior point on the knee in squatting posture.	
47	**Buttock to Foot Distance (S_{33}):** Maximum horizontal distance from the rearmost point of the uncompressed buttocks to the foremost point of the foot in squatting posture.	
48	**Buttock to Heel Distance (S_{34}):** Maximum horizontal distance from the rearmost point of the uncompressed buttocks to the rear most point of the heels in squatting posture.	

Sr. No.	Operational Definition	Illustration
49	**Squatting Vertical Arm Reach (D_{27}):** Squatting in erect posture, vertical arm reach height from floor.	
50	**Squatting Vertical Grasp Reach (D_{28}):** Squatting in erect posture, vertical grasp reach height from floor.	
51	**Squatting Upper (D_{29}), Mid (D_{30}) and Lower Position (D_{31}) Arm Reach Length**: Squatting in erect posture, horizontal distance from wall to higher level, mid level and low level arm reach point.(Plate 8)	
52	**Squatting Upper (D_{32}) and Mid Position (D_{33}) Arm Reach Height:** Squatting in erect posture, vertical distance from floor to higher level and mid level arm reach point. (Plate 9)	

Sr. No.	Operational Definition	Illustration
53	**Squatting Upper (D_{34}), Mid (D_{35}) and Lower Position (D_{36}) Grasp Reach Length**: Squatting in erect posture, horizontal distance from wall to higher level, mid level and low level grasp reach point.	
54	**Squatting Upper (D_{37}) and Mid Position (D_{38}) Grasp Reach Height:** Squatting in erect posture, vertical distance from floor to higher level and mid level grasp reach point.	

3.6 Setting of Hypothesis

A hypothesis in statistics is simply a quantitative statement about population. It is an assumption made about parameter values and then its validity is tested by statistical technique, which ultimately tells about whether the hypothesis is correct and is sustained, or whether it is false and is to be rejected (Elhance, 1984). On the basis of theoretical considerations the following hypothesis was set for rational statistics.

"Dynamic Anthropometry of Women Is Related with Static Anthropometry of Women."

On the basis of above statement following null hypothesis was set for possible rejections.

"The Correlation Between Static and Dynamic Anthropometry of Women is Zero." r (S, D) = 0

Where 'r' is correlation coefficient,
'S' is static anthropometry and
'D' is dynamic anthropometry

3.7 Analysis Strategy

The tabulation and data analysis plan was developed prior to questionnaire administration and proceeded from simple to complex. Statistical procedures were adapted to test the set hypothesis.

3.7.1 Categorization of Demographic Variables

For the purpose of tabulation demographic variables of the respondents were categorized as given below:

3.7.1.1 Age

Age was measured in terms of number of full years the respondent completed at the time of interview. It was categorized as

i) 25 - 35 years

ii) 35 – 45 years

3.7.1.2 Education

Operationally education referred to the formal education attained by the respondents. Respondent were categorised as per their educational level as

i) Illiterate,
ii) School educated,
iii) College educated
iv) Post graduates.

3.7.1.3 Family Income

Family income refers to the monthly income in terms of money accrued from various sources. Income levels of families were categorised as

i) Rs. 5000 and below,

ii) Rs. 5000-Rs. 10, 000,

iii) Rs. 10,000 – Rs.15, 000

iv) More than Rs. 15,000

3.7.1.4 Family Size

Family size refers to the total number of members in the family consisting husband, wife, children and others. On the basis of members existing in the family families were categorised as

i) Small family (1-4 members),

ii) Medium family (5-8 members)

iii) Large family (more than 8 members)

3.7.1.5 Type of Family

Type of families are categorised on the basis of structure of families as

i) Nuclear

ii) Joint families.

3.7.2 The Statistical Techniques Used

Statistical techniques are essential in any research for systematic analysis and presentation of facts. The first analytic step was the generation of simple descriptive statistics like frequency, percentages, mean, percentile and standard error. These statistics provide a quick assessment of data quality and descriptive characteristics of the study population. The collected data were tabulated and analysed with the help of subjective and rational statistics.

3.7.2.1 Frequency

Frequency was calculated to find out the number of women falling in specific group with respect to demographic variables.

3.7.2.2 Percentage

The percentage was used for making simple comparison. For calculating percentage the frequency of a particular cell was divided by the total number of respondents in that particular category and multiplied by 100. Percentage was calculated up to two places after the decimal point. Percentages were calculated by using the formula

$$P\ (\%) = \frac{n}{N} \times 100$$

Where, n = frequency of particular cell

N = Total number of respondents of that particular cell

P = Percentage.

3.7.2.3 Mean

Mean is defined as any Figure that conveys the characteristic of any group to the maximum extent (Bajpai, 1976). The mean was calculated for all static and dynamic anthropometric measurements of women by using the formula

$$Mean = \frac{\sum \mathrm{Re}\,sponses}{Total\ Number\ of\ \mathrm{Re}\,sponses}$$

3.7.2.4 Percentile

Most anthropometric data are quite often expressed in terms of percentiles. Percentile indicates the percentage of persons within the population who have certain size of specific variable. The data is divided for study purposes into 100 percentage categories, ranked from least to greatest with respect to some specific type of body measurement. It is usually not possible to design workplaces to suit the very biggest or the very smallest workers so we must be content with meeting the requirement of the majority. A selection is, therefore, made for the central 90 per cent of a group fitting the persons bigger than the smallest 5 per cent and smaller than the biggest 5 per cent. Percentile for all anthropometric measurements were calculated by using formula (Garrett and Woodworth, 1981)

$$Pp = l + (p^N - F/fp) \times i$$

Where Pp = percentages of the distribution wanted

l= Exact lower limit of the class interval upon which Pp lies.

P^N = part of N to be counted off in order to reach Pp

F= Cumulative frequency up to l

fp= No. of scores within the intervals upon which Pp falls.

i= Width of the interval

3.7.2.5 Standard Error

Standard error provides an idea about the degree of precision of a sample or in other words tells about the extent to which a sample is reliable. (Elhance, 1984). It is used to know the confidence interval of the arithmetic mean.

Along with mean the standard error for all static and dynamic anthropometry of women was calculated by using the formula

$$SE = \sigma / \sqrt{N}$$

Where, SE = standard error

σ = Standard deviation and

N = sample size

3.7.2.6 Correlation

Correlation is merely a tool of ascertaining the degree of association between two variables whereas; multiple correlation coefficient gives the effect of all independent variables on a dependant variable (Elhance, 1984). When two variables change together in such a way that an increase in one variable is accompanied by an increase in other the variables are said to be positively correlated. An increase in one variable goes hand in hand with a decrease in the other, these two variables are said to be negatively correlated. If there is no relationship between two variables they are said to be independent or uncorrelated. (Garrett and Woodworth, 1981).

The intensity of correlation is measured by a correlation coefficient usually indicated by the symbol ‘r’. Correlation coefficient was computed for testing the relationship between static and dynamic anthropometry of women by using the formula

$$\text{‘}r\text{’}(x,y) = \frac{Co\,\mathrm{var}\,iance\ (x, y)}{\sqrt{Variane\ (x).\,\mathrm{var}\,iance\ (y)}}$$

Where, ‘r’= Correlation coefficient,

x = Independent variable and

y = Dependant variable

3.7.2.7 Regression

Regression is a measure of the average relationship between two or more variables in terms of the original units of the data. Thus, regression analysis attempts to establish the nature of the relationship between two variables. It studies the functional relationship between the variables and thereby provides a mechanism for predicting or estimating the unknown value of one variable from known value of other variable (Elhance, 1984). Simple and multiple regression analysis were done to determine better predictors of dynamic anthropometry of women.

3.7.2.8 Coefficient of Determination (R^2)

One very convenient and useful way of interpreting the value of coefficient of correlation between two variables is to use the square of coefficient of correlation. It measures the effect of independent variable on the dependant variable and gives an indication about the predictive value of the regression studies. (Elhance, 1984) Coefficient of determination for seeing the effect of all static measurements on dynamic measurements was calculated by using the formula

$$\textit{Coefficient of Determination } (R^2) = \frac{\textit{Explained Variance}}{\textit{Total Variance}}$$

3.7.2.9 Developing The Statistical Models

Statistical modeling was carried out on the basis of regression equations**.** Regression equations are frequently used to predict anthropometric descriptors of the human body from a set of known data. Regression equations are also known as estimating equations and are algebraic expressions of the regression lines. These lines are expressed as $\hat{Y}= a+bx+u$ where ‘a’ and ‘b’ are constants which determine the position of line completely. These constants are called the parameters of the line. ‘a’ determines the level of fitted line i.e. the distance of the line directly above or below the origin. The parameter ‘b’ determines the slope of line i.e. the change in 'y' per unit change in 'x' (Gupta, 1992). Thus, the Simple Correlation and Regression Analysis is only relationship between two variables however more than two static measurements may influence dynamic measurements of women. To know the partial response of different independent variables (Si) simultaneously on the dependant variable (di) the multiple regression analysis was carried out.

On the basis of conclusions derived through observation schedule and statistical analysis the statistical models in the form of regression equation were framed. The conceptual Multiple Regression Models were as given below:

$$D_i=b_0+b_1s_1+b_2s_3+b_3s_3+\text{----------------}b_is_i+U$$

Where, D_i = Dynamic anthropometry for i^{th} variable

S_1-------S_i = Static anthropometry from 1 to i^{th} Variable

b_0 = intercept

b_1----------b_i = Partial regression coefficient of D_i with S_1---------S_i

U = Random variable

3.6.2.10 Testing The Significance of Developed Statistical Model

Developed statistical models in the form of regression equation were tested on 80 randomly selected women exclusive of original sample by applying Chi Square (χ^2) test. Chi Square test represents a useful method of comparing experimentally obtained results with those to be observed results.

The formula for Chi Square (χ^2) is stated as follows:

$$\text{Chi Square } (\chi^2) = \sum \frac{(O-E)2}{E}$$

Where 'O' = Observed value and

'E' = Estimated value from the developed model.

The differences between observed and estimated values are squared and then divided by the estimated values. The more closely the observed results approximate to the estimated results, smaller the χ^2 and the closer agreement between estimated data whereas, larger the χ^2 the greater the probability of a real divergence of experimentally observed values from estimated results (Garret and Woodworth, 1981).

RESULTS AND DISCUSSION

The present investigation entitled "Statistical Modeling of Relationship between Static and Dynamic Anthropometry of Women" was undertaken with the objectives of studying static and dynamic anthropometry of women in standing and squatting position, assessing the relationship between static and dynamic anthropometry of women and developing a statistical model based on the assessed relationship. A survey among 500 randomly selected women in the age group of 25-45 years was conducted and various static and dynamic anthropometric measurements of women in standing as well as squatting position were recorded through framed observation schedule.

The collected data were consolidated, compiled, statistically analysed, tabulated and presented under the following heads.

4.1 Demographic Information of Women.

4.2 Standing Anthropometry of Women.

4.3 Squatting Anthropometry of Women.

4.4 Relationship Between Standing Static and Vertical Dynamic Anthropometry of Women.

4.5 Relationship Between Standing Static and Horizontal Dynamic Anthropometry of Women.

4.6 Relationship Between Squatting Static and Dynamic Anthropometry of Women.

4.7 Statistical Models For Relationship Between Static and Dynamic Anthropometry of Women in Standing and Squatting Position.

4.8 Testing Goodness of Fit of Developed Statistical Models

4.9 Testing of Hypothesis

4.1 Demographic Information of Selected Women

Demographic distribution of selected women is presented in Table 1 and illustrated in Figure 1.

It is observed from the Table that majority of the women (73 %) were of age group between 25 and 35 years. Only 27 per cent women selected were from the age group of 35 to 45 years. Approximately similar percentages were noted for school educated (39.4%) and college educated women (41.8%). The percentage of postgraduate women was less (12.4%) followed by illiterate women (6.4%).

The percentage of women belonging to the families with monthly income of Rs.5001 to Rs. 10,000 was 47.8 per cent. Whereas, 26.8 per cent women belonged to the families with monthly income between Rs. 10,000 and Rs.15, 000. Twenty point four per cent women were having monthly family income below Rs.5, 000/-. The lowest percentage of surveyed women (5%) was belonging to the families with highest monthly income i.e. above Rs. 15,000/- per month. Majority of the women surveyed were from nuclear families (62%) and 38 per cent women were belonging to joint families. Equal percentage of 44.8 was observed regarding the women belonging to families having 1-4 and 5-8 members in the family while only 10.4 per cent women were from the families with more than 8 members.

Table 1 Demographic Distribution of The Selected Women

Demographic Variables	Frequency	Percentage
Age Group (Yrs)		
25-35	365	73
35-45	135	27
Education		
Illiterate	32	6.4
School educated	197	39.4
College educated	209	41.8
Post graduate	62	12.4
Monthly Income (Rs.)		
Up to 5000	102	20.4
5001-10,000	239	47.8
10,000-15,000	134	26.8
More than 15,000	25	5.0
Type of Family		
Joint	190	38
Nuclear	310	62
Family size (No.)		
1-4	224	44.8
5-8	224	44.8
> 8	52	10.4

Thus, it is concluded that majority of the women surveyed were between the age group of 25-35 years, college educated having monthly income between Rs.5, 000 and Rs.10, 000. Majority of the women were belonging to nuclear families having 1-4 and 5-8 members in the family.

4.2 Standing Anthropometry of Women

4.2.1 Standing Static Anthropometry of Women

Statistical descriptors for standing static anthropometry of selected women is enumerated in Table 2 and presented in Figure 2.

It is clear from the Table that mean normal standing height of women was 152.47 cm ranging from 130 and178 cm. Stature of women was 153.11 cm with the range of 131 - 179 cm. Mean eye height of women was recorded as 143.31 cm and delimited by the range of 104 -160 cm. The average measurement of mid-shoulder height (132.41 cm) ranged between 106 cm and151 cm. The average length measurements for hand, elbow to middle finger, and palm were 69.55 cm, 42.79 cm and 19.89 cm respectively with corresponding range of 42-94 cm, 36-53 cm and 17-26 cm. The average height measurements from floor to elbow, abdominal extension, waist, and buttock extension, tip of radius and tip of middle finger were 99.71 cm, 93 cm, 95.34 cm, 86.87 cm, 76.55 cm and 59.58 cm respectively. Respective ranges of elbow height, abdominal extension height, waist height and buttock extension height, tip of radius height and tip of middle finger height from floor were 76 - 134cm; 80-109cm; 81-111cm; 74-102cm; 65-93cm and 50-82cm

Fifth percentile values of normal standing height, stature, eye height and mid-shoulder height indicated that only 5 per cent of women surveyed were having normal standing height less than 144 cm, stature less than 144.5 cm, eye height less than 134cm and mid-shoulder height less than 124 cm. The values of ninety-fifth percentile of normal standing height, stature, eye height and mid-shoulder height indicated that only 5 per cent of women surveyed were having normal standing height more than 161.01cm, stature more than 162.02 cm and mid-shoulder height more than 140 cm.

Table 2 Statistical Descriptors of Standing Static Anthropometry of Selected Women

Anthropometric Variables	**Mean ± Standard Error (Cm)**	**Minimum (Cm)**	**Maximum (Cm)**	**5th percentile (Cm)**	**95th percentile (Cm)**
Normal Standing (S_1)	152.47 ± 0.25	130	178	144	161.01
Stature (S_2)	153.11 ± 0.25	131	179	144.5	162.02
Eye Height (S_3)	143.31 ± 0.26	104	160	134	153
Mid Shoulder Height (S_4)	132.41±0.34	106	151	124	140
Hand Length (S_5)	69.55 ± 0.18	42	94	64	75
Elbow- Middle Finger (S_6)	42.79 ± 0.10	36	53	39	46
Palm Length (S_7)	19.89 ± 0.06	17	26	18	22
Elbow Height (S_8)	99.71 ± 0.21	76	134	92	106
Abdominal Extension Height (S_9)	93 ± 0.19	80	109	86	100
Waist Height (S_{10})	95.34 ± 0.2	81	111	88	102
Buttock Extension (S_{11})	86.87 ± 0.21	74	102	80	95
Tip Of Radius (S_{12})	76.55 ± 0.17	65	93	70	83
Tip Of Middle Finger (Dactylion) (S_{13})	59.58 ± 0.17	50	82	54	66

The values for fifth and ninety-fifth percentile for hand length, elbow to middle finger length and palm length indicated that 90 per cent of women were having hand length between 64 and75 cm, elbow to middle finger length between 39 and46 cm and palm length between 18 and 22 cm. Fifth percentile values recorded for elbow height, abdominal extension height, waist height, buttock extension height, tip of radius height and tip of middle finger height indicated that only 5 per cent women were falling below 92 cm for elbow height, 86 cm for waist height, 80 cm for buttock extension height, 70 cm for tip of radius height and 54 cm for tip of middle finger height. Corresponding ninety-fifth percentile values for elbow height, abdominal extension height, waist height and buttock extension height, tip of radius height and tip of middle finger height were 106 cm, 100 cm, 102 cm, 95 cm, 83 cm and 66cm. These values indicated that the 5 per cent women were having elbow height, abdominal extension height, waist height, and buttock extension height, tip of radius height and tip of middle finger more than the above said measurements. It was clear from the recorded measurements that the standing static measurements of women were having wide variation.

Mean values of stature of women reported in present study is at par with the findings of Varghese *et al.* (1989) among women from Mumbai and Liu *et al.* (1999) among female operator in Maquiladora plant. Eye height of women recorded in the present study is in line with results of Hissar women reported by Verma and Oberoi (2000).

Mid-shoulder height reported in this study is in confirmation with the findings of Mououdi (1997), Verma and Oberoi (2000) and Singh *et al.* (2004) of female from Tehran, Hissar and Kumaon hills respectively. The recorded hand length of women in this investigation is confirmed by the findings reported by Kumar and Parwati (2001) of Tamilnadu women.

4.2.2 Depth and breadth measurements of selected women in standing position

Statistical descriptors for depth and breadth measurements of selected women in standing position is presented in Table 3 and illustrated in Figure 3.

It is evident from the Table that mean span and span akimbo of selected women was 158.52cm and 84.2cm respectively. The average body breadth of selected women was 40.88cm. The mean depth measurements of chest and body were 21.2cm and 26.31cm respectively. The range of span was observed between 137.5cm and 182cm whereas; it was 72 and 97cm for span akimbo of selected women. Body breadth of selected women ranged between 27 and 75cm. The depth for chest was ranging between 14cm and 38cm and depth of body was between 18cm and 39cm. Thus, a wide variation of depth and breadth measurements was noticed between minimum and maximum measurements of selected women, which may be due to varied, body built of women.

Table 3 Statistical Descriptors of Depth and Breadth Measurements of Selected Women in Standing Position

Anthropometric Variables	Mean±Standard Error (Cm)	Minimum (Cm)	Maximum (Cm)	5^{th} percentile (Cm)	95^{th} percentile (Cm)
Span (S_{14})	158.52 ± 0.30	137.5	182	147.5	169.02
Span Akimbo (S_{15})	84.2 ± 0.19	72	97	76.95	91
Body Breadth (S_{16})	40.88 ± 0.20	27	75	34	48
Chest Depth (S_{17})	21.2 ± 0.15	14	38	17	27
Body Depth (S_{18})	26.31 ± 0.15	18	39	21	32

Fifth percentile values for span, span akimbo, body breadth, chest depth and body depth indicated that only 5 per cent women were having span measurements less than 147.5cm, span akimbo less than 76.95cm, body breadth less than 34 cm, chest depth less than 17 cm and body depth less than 21cm.Ninety fifth percentile values indicated that 5 per cent women were having span more than 169.02cm, span akimbo more than 91cm, body breadth more than 48cm, chest depth more than 27cm and body depth more than 32 cm.

On the whole wide variations were noticed in the breadth and depth measurements of selected women

4.2.3 Circumference Measurements of Selected Women in Standing Position

Statistical descriptors for circumference measurements of selected women in standing position is reported in Table 4 and depicted in Figure 4.

It is apparent from the Table that mean mid-tidal circumference of selected women was 85.88cm delimited by minimum of 66 cm and maximum of 111 cm. Wide range of abdominal extension between 45cm and 121cm with average value of 90.68cm was noted for selected women. Mean value of waist circumference was 77.75 cm within the range of 53 and 110 cm. Circumference of hip at gluteal extension was 96.72 cm between the ranges of 67.5cm and127cm. Mean arm circumference of selected women was 27.06 cm with minimum of 19 cm and maximum of 39 cm.

Fifth percentile and ninety-fifth percentile values of mid tidal circumference indicated that 5 per cent of women were having mid tidal circumference below 73cm and above 100cm respectively. Abdominal extension circumference indicated 75 cm as fifth percentile and 107 cm as ninety-fifth percentile indicating that 5 per cent women were having less than 75 cm abdominal extension circumference and 5 per cent women were having abdominal circumference above 107 cm. Fifth and ninety-fifth percentile values for waist circumference, hip at gluteal extension and arm circumference indicated that 90 per cent women were having waist circumference between 62 and 95 cm, hip at gluteal extension between 82.95 and 111 cm and arm circumference between 22 and 32 cm.

Table 4 Statistical Descriptors of Circumference Measurements of Selected Women in Standing Position

Anthropometric Circumference	Mean±Standard Error (Cm)	Minimum (Cm)	Maximum (Cm)	5^{th} percentile (Cm)	95^{th} percentile (Cm)
Mid Tidal (S_{19})	85.88 ± 0.37	66	111	73	100
Abdominal Extension (S_{20})	90.68 ± 0.46	45	121	75	107
Waist (S_{21})	77.75 ± 0.45	53	110	62	95
Hip at Gluteal Extension (S_{22})	96.72 ± 0.39	67.5	127	82.95	111
Arm (S_{23})	27.06 ± 0.13	19	39	22	32

From the above findings it can be inferred that there was wide variation in minimum and maximum measurements as well as fifth and ninety-fifth percentile values of selected body circumferences like abdominal extension, waist and hip at gluteal extension of selected women.

The average waist and hip circumference recorded for women in present study are in conformation with the findings of Bhattacharya and McGlothlin (1996).

4.2.4 Vertical Dynamic Anthropometry of Women in Standing Position

Statistical descriptors for vertical dynamic anthropometry of women in standing position is displayed in Table 5 and illustrated in Figure 5.

It is visible from the Table that mean vertical upward arm reach and vertical upward grasp reach of women were 195.18cm and 187.51 cm respectively in the range of 158 cm – 231 cm and 150-221cm. Average height recorded of selected women in upper, mid and lower position was 187.69cm, 129.33cm and 67.61cm respectively.

Table 5 Statistical Descriptors of Vertical Dynamic Anthropometry of selected Women in Standing Position

Anthropometric Variables	Mean±Standard Error (Cm)	Minimum (Cm)	Maximum (Cm)	5^{th} percentile (Cm)	95^{th} percentile (Cm)
Vertical Upward Arm Reach (D_1)	195.18±0.5	158	231	183	208
Vertical Upward Grasp Reach (D_2)	187.51±0.33	150	221	175.5	199
Upper Position Arm Reach Height (D_6)	187.69±0.36	164	225	175	202
Mid Position Arm Reach Height (D_7)	129.33±0.22	110	153	121	137
Lower Position Arm Reach Height (D_8)	67.61±0.25	53	95	60	78.05
Upper Position Grasp Reach Height (D_9)	180.79±0.38	150	215	166	194.05
Mid Position Grasp Reach Height (D_{10})	129.73±0.28	73	154	122	138
Lower Position Grasp Reach Height (D_{11})	75.36±0.27	51	96	66	86
Forward Upper Position Arm Reach Height (D_{18})	176.54±0.37	128	200	164	190
Forward Mid Position Arm Reach Height (D_{19})	125.88±0.26	101	145	115	134
Forward Lower Position Arm Reach Height (D_{20})	17.87±0.14	10	29	12	24
Forward Upper Position Grasp Reach Height (D_{24})	171.14±0.36	110	204	158.95	183
Forward Mid Position Grasp Reach Height (D_{25})	126.99±0.26	99	152	117	135
Forward Lower Position Grasp Reach Height (D_{26})	26.29±0.15	18	38	20	31

Corresponding ranges for vertical reach of women in upper, middle and lower position were 164-225cm; 110-153cm and 53-95cm. Mean grasp reach height at upper, mid and lower position was recorded as 180.79cm, 129.73cm and 75.36cm respectively. The range of upper position grasp reach height was between 150 and 215 cm, mid position grasp reach height was between 73 and 154cm and lower position grasp reach height was between 51 and 96cm.

Forward reach of women at upper, mid and lower position was 176.54cm, 125.88 cm and 17.87 cm respectively. The corresponding ranges for forward reach of women at upper, mid and lower position were 128-200 cm; 101-145cm and 10-29cm. Forward grasp reach height at upper, mid and lower position were 171.4 cm, 126.99 cm and 26.29 cm respectively. The respective range in which forward grasp reach height of women was falling for upper, middle and lower position was between 110-204 cm, 99-152 cm and 18-38 cm.

Fifth percentile values for vertical dynamic measurements of selected women indicated that the 5 per cent women were having vertical upward arm reach below 183 cm and vertical upward grasp reach below 175.5 cm while the ninety-fifth percentile value indicated that 5 per cent of women were having vertical upward arm reach more than 208cm and grasp reach more than 199cm.

Fifth percentile values for reach height at upper, mid and lower position indicated that 5 per cent of women were having upper position reach height less than 175cm, mid position reach height less than 121cm and lower position reach height less than 60 cm whereas, ninety-fifth percentile values for reach height at upper, mid and lower position indicated that 5 per cent of selected women were having upper position reach height more than 202cm, mid position reach height more than 137cm and lower position height more than 78.05 cm.

Fifth and ninety-fifth percentile values for upper, mid and lower position grasp reach height indicated that 90 per cent of selected women were having upper position grasp reach height between the range of 166cm and 194.05cm, mid position grasp reach height in the range of 122cm and 138cm and lower position grasp reach height between the range of 66cm and 86cm.

Forward upper, mid and lower position height as per their corresponding fifth and ninety-fifth percentile values indicated that 90 per cent of selected women were having forward upper position reach height between 164 and190cm, forward mid position reach height between 115 cm and 134cm and forward lower position reach height between 12 and 24 cm. The grasp reach height at forward upper position, forward mid position and forward lower position as per fifth and ninety-fifth percentile values indicated that the 90 per cent women were having forward upper position grasp reach height between 158.95cm and 183cm, forward middle position grasp reach height between 117 cm and 135 cm and forward lower position grasp reach height between 20 and 31cm.

On the whole it was found that the range was wide for recorded vertical dynamic anthropometry of women in standing position.

Vertical reach of women from present investigation is at par with the vertical reach measurements of Taiwanese and Korean female as reported by Cheng *et al.* (2004)

4.2.5 Horizontal Dynamic Anthropometry of Selected Women in Standing Position

Statistical descriptors for horizontal dynamic anthropometry of selected women in standing position is given in Table 6 and illustrated in Figure 6.

It is seen from the Table that mean length measurements of selected women at upward, middle and lower position were 75.34cm, 83.45cm and 73.16cm in the range of 51cm-98cm, 59cm-105cm and 51cm-95cm respectively. Mean values for grasp reach length of women at upper position, middle position and lower position were recorded as 67.5cm, 75.62cm and 65.33cm respectively in the corresponding ranges of 42-89cm, 48-96cm and 41-86cm. Mean upper position reach length of women in forward position was 75.75cm in the range of 54-107cm Whereas, mean middle position reach length of women in forward position was 107.49cm in the range of 86cm and134 cm. Forward lower position reach length of women was delimited by 35 and 110cm with mean value of 53.68cm. The forward grasp reach length at upper, middle and lower position was 69.13cm, 98.85cm and 49.84cm respectively with corresponding ranges of 50-103cm, 78-123cm and 30-90cm. Percentile values indicated that 5 per cent women were having upward position length less than 65cm and more than 85cm, middle position length less than 75cm and more than 92cm and lower position length less than 63cm and more than 83cm.

Fifth and ninety-fifth percentile values for grasp reach length of women at upper, middle and lower position indicated that 90 per cent of women were having upper grasp reach length between 58 and 78 cm, middle position grasp reach length between 67 and 84 cm and lower position grasp reach length between 56 and76cm. Forward upper position reach length, middle position reach length and lower position reach length was observed to be between 64 and 89cm, 94.95 and

120 cm and 39cm and 71 cm respectively for 90 per cent of selected women as indicated by percentile values.

Table 6 Statistical Descriptors of Horizontal Dynamic Anthropometry of Selected Women in Standing Position

Anthropometric Variables	Mean±Standard Error (Cm)	Minimum (Cm)	Maximum (Cm)	5^{th} percentile (Cm)	95^{th} percentile (Cm)
Upper Position Arm Reach Length (D_3)	75.34±0.27	51	98	65	85
Mid Position Arm Reach Length (D_4)	83.45±0.24	59	105	75	92
Lower Position Arm Reach Length (D_5)	73.16±0.27	51	95	63	83
Upper Position Grasp Reach Length (D_{12})	67.5±0.27	42	89	58	78
Mid Position Grasp Reach Length (D_{13})	75.62±0.24	48	96	67	84
Lower Position Grasp Reach Length (D_{14})	65.33±0.27	41	86	56	76
Forward Upper Position Arm Reach Length (D_{15})	75.75±0.35	54	107	64	89
Forward Mid Position Arm Reach Length (D_{16})	107.49±0.35	86	134	94.95	120
Forward Lower Position Arm Reach Length (D_{17})	53.68±0.48	35	110	39	71
Forward Upper Position Grasp Reach Length (D_{21})	69.13±0.36	50	103	56	82.05
Forward Mid Position Grasp Reach Length (D_{22})	98.85±0.35	78	123	86	112.05
Forward Lower Position Grasp Reach Length (D_{23})	49.84±0.47	30	90	35	66.05

Fifth and ninety-fifth percentile values for forward upper position grasp reach length, middle position grasp reach length and lower position grasp reach length indicated that 90 per cent women were having forward grasp reach length at upper position, middle position and lower position between the range of 56-82.05cm, 86-112.05cm and 35-66.05cm respectively.

It can be concluded that the horizontal dynamic measurements of women were having wide variation between minimum and maximum values.

Arm reach of women from wall recorded in the present study is in line with the findings reported by Gite and Yadav (1989)

4.3 Squatting Anthropometry of Women

4.3.1 Squatting static Anthropometry of Women

Statistical descriptors for squatting static anthropometry of selected women in squatting position is presented in Table 7 and illustrated through Figure 7

It is obvious from the Table that mean normal squatting height of selected women was 86.14cm delimited by minimum of 62cm and maximum of 100cm squatting height. Mean erect squatting height was recorded as 87.6 cm in the range of 63 and 101 cm mid-shoulder height and right knee height in squatting position ranged between 55 and 80 cm and 34 and 56 cm with average of 67.55 cm and 44.47 cm respectively.

Average relaxed distance between elbow-to-elbow, knee-to-knee, heel-to-heel and big toe to big toe of women in squatting posture was recorded as 44.17, 34.17, 17.09 and 22.02 cm respectively. Corresponding ranges for the distance between elbow to elbow, knee to knee, heel to heel and big toe to big toe were 30-62 cm, 20-59 cm, 8-28 cm, and 13-38 cm. The average length measurements of women in squatting posture from buttock to knee was recorded as 45.81 cm in the range of 32-60cm. The range for buttock to foot distance and buttock to heel distance was 30-54 cm and 19-50 cm respectively with corresponding mean value of 40.13 cm and 17.46 cm.

Table 7 Statistical Descriptors of Squatting Static Anthropometry of Selected Women

Anthropometric Variables	Mean±Standard Error (Cm)	Minimum (Cm)	Maximum (Cm)	5^{th} percentile (Cm)	95^{th} percentile (Cm)
Normal Squatting Height (S_{24})	86.14 ± 0.20	62	100	79	93
Erect Squatting Height (S_{25})	87.6 ± 0.20	63	101	80.5	95
Mid Shoulder Height (S_{26})	67.55 ± 0.19	55	80	61	74.05
Right Knee Height (S_{27})	44.47 ± 0.16	34	56	38	50
Elbow to Elbow Relaxed (S_{28})	44.17 ± 0.24	30	62	36	54
Knee to Knee Relaxed (S_{29})	34.17 ± 0.29	20	59	25	47
Heel to Heel Relaxed (S_{30})	17.09 ± 0.18	8	28	11	24
Big Toe to Big Toe Relaxed (S_{31})	22.02 ± 0.18	13	38	15	29
Buttock to Knee Length (S_{32})	45.81 ± 0.18	32	60	39	52
Buttock to Foot Distance (S_{33})	40.13 ± 0.16	30	54	35	46
Buttock to Heel Distance (S_{34})	17.46 ± 0.22	19	50	12	28

Fifth and ninety-fifth percentile values of normal squatting height and erect squatting height indicated that 90 per cent of selected women were in the range of 79 and 93 cm for normal squatting height and 80.5 and 95 for erect squatting height. Mid-shoulder height recorded 61 cm as fifth percentile and 74.05cm as ninety-fifth percentile which indicated that 5 per cent women were having mid-shoulder squatting height less than 61 cm and more than 74.05 cm. Right knee height percentile values for 5 and 95 indicated that the range of right knee height in squatting position was between 38 cm and 50 cm. The percentile values at fifth and ninety-fifth rank for relaxed distance between elbow to elbow, knee to knee, heel to heel and big toe to big toe indicated that 5 per cent women were having elbow to elbow distance below 36 cm, knee to knee distance below 25 cm, heel to heel distance below 11 cm and big toe to big toe distance below 15 cm. Whereas, the distance between elbow to elbow, knee to knee, heel to heel and big toe to big toe was observed to be more than 54cm, 47cm, 24cm and 29 cm respectively among 5 per cent women.

The length from buttock to knee was observed to be between 39 and 52 cm for 90 per cent women as indicated by fifth and ninety-fifth percentile values. The buttock to foot and buttock to heel distance of women in squatting posture was found to be less than 35 and 12 cm respectively for 5 per cent of women as indicated by fifth percentile values and more than 46 cm and 28 cm for 5 per cent of women as revealed by ninety-fifth percentile values.

On the whole it was found that the squatting static anthropometry varied with wide range among selected women.

Squatting shoulder height of women reported in the present investigation is on par with that of women from Dharwad, Hyderabad and Udaipur as reported by Verma and Oberoi (2000).

4.3.2 Squatting Dynamic Anthropometry of Women

Statistical descriptors of squatting dynamic anthropometry of selected women are presented in Table 8 and in Figure 8.

It is perceptible from the Table that vertical arm reach and vertical arm grasp reach of women in squatting posture was 129.99 cm and 122.15 cm respectively in the corresponding range of 113-172 cm and 106-164 cm. The arm reach length at upper, middle and lower position was recorded as 56.04, 82.11 and 74.16 cm respectively and delimited by corresponding ranges of 39-96 cm, 62-97 cm and 57-91cm. The arm reach height at upper and mid position in squatting posture of women was observed to be 104.4 cm and 63.51cm respectively with the range of 57-91cm and 52-89 cm. The grasp reach length at upper, mid and lower position was noticed within the range of 37-82 cm, 56-99 cm and 55-85 cm respectively with corresponding averages of 52.07 cm, 75.62 cm and 68.97 cm. The upper position grasp reach height and mid position grasp reach height of selected women in squatting position was found to be 100.58 and 59.72 cm respectively with the corresponding ranges of 75-113 cm and 48-86 cm.

Fifth and ninety-fifth percentile values for vertical arm reach in squatting position of women indicated that 95 per cent of women were having vertical arm reach more than 121cm and less than 139 cm and vertical grasp reach

more than 114 cm and less than 130.05 cm. As indicated by fifth and ninety-fifth percentile values for upper position arm reach length, mid position arm reach length and lower position reach length 90 per cent women were having upper position arm reach length with the range of 45-70 cm, mid position arm reach length with the range of 74-90 cm and lower position arm reach length between 65 and 84 cm.

Table 8 Statistical Descriptors of Dynamic Anthropometry of Selected Women in Squatting Position

Anthropometric Variables	Mean±Standard Error (Cm)	Minimum (Cm)	Maximum (Cm)	5^{th} percentile (Cm)	95^{th} percentile (Cm)
Vertical Arm Reach (D_{27})	129.99 ± 0.25	113	172	121	139
Vertical Grasp Reach (D_{28})	122.15 ± 0.24	106	164	114	130.05
Upper Position Arm Reach Length (D_{29})	56.04 ± 0.38	39	96	45	70
Mid Position Arm Reach Length (D_{30})	82.11 ± 0.23	62	97	74	90
Lower Position Arm Reach Length (D_{31})	74.16 ± 0.24	57	91	65	84
Upper Position Arm Reach Height (D_{32})	104.4 ± 0.21	57	91	97	112.05
Mid Position Arm Reach Height (D_{33})	63.51 ± 0.18	52	89	57	70
Upper Position Grasp Reach Length (D_{34})	52.07 ± 0.35	37	82	41	66.05
Mid Position Grasp Reach Length (D_{35})	75.62 ± 0.23	56	99	67	84
Lower Position Grasp Reach Length (D_{36})	68.97 ± 0.23	55	85	60	78
Upper Position Grasp Reach Height (D_{37})	100.58 ± 0.21	75	113	93	109
Mid Position Grasp Reach Height (D_{38})	59.72 ± 0.18	48	86	53	66

Fifth percentile values for arm reach height at upper and mid position indicated that 5 per cent women were having upper position arm reach height below 97 cm and mid position arm reach height below 57 cm. Whereas, ninety-fifth percentile values indicated that only 5 per cent women were having upper position arm reach height and mid position arm reach height more than 112.05 cm and 70 cm respectively. The grasp reach length with their fifth and ninety-fifth percentile indicated that 90 per cent women were having upper position grasp reach length of women in squatting position in the range of 41 and 66.05 cm; mid position grasp reach length in the range of 67-84 cm and lower position grasp reach length between 60 and 78 cm.

Fifth percentile value for upper position grasp reach height and mid position grasp reach height indicated that 5 per cent of women were having upper position grasp reach height less than 93 cm and mid position grasp reach height less than 53 cm. Ninety-fifth percentile for grasp reach height at upper position and middle position indicated that 5 per cent of women were having upper position grasp reach height more than 109cm and mid position grasp reach height more than 66 cm.

On the whole the variations in majority of squatting dynamic anthropometry were noticed in selected women.

4.4 Relationship Between Standing Static and Vertical Dynamic Anthropometry of Women

Initially the study included total 23 standing static measurements, which were denoted as independent variables. Dynamic measurements considered as dependant variables in the study were reach measurements of women in vertical and horizontal plane. Depending upon logistic theoretical approach only vertical linear static measurements were considered for statistical analysis leaving aside five circumference measurements and five body depth and breadth measurements. Thus, out of 23 standing static measurements, 13 vertical linear measurements were selected for analysis. The significance of actual correlation, theoretical importance of positions and utility of measurements, only five standing static measurements out of 13 and arm span were considered for final multiple regression analysis as explanatory variables which were adequate and sufficient to describe the phenomena of dynamic anthropometry of women in standing position. The six standing static measurements included in the final analysis were normal standing height (S_1), mid-shoulder height (S_4), hand length (S_5), elbow height (S_8), waist height (S_{10}) and span (S_{14}) of women.

4.4.1 Relationship Between Standing Static Anthropometric Measurements and Vertical Upward Arm Reach

4.4.1.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Vertical Upward Arm Reach of Women

Simple correlation and regression analysis between standing static anthropometry and vertical arm reach of women is reported in Table 9 and illustrated in Figure 9.

It is clear from the Table that vertical upward arm reach from floor was positively correlated with selected static measurements like normal standing height ($r=0.87^{**}$); mid-shoulder height ($r=0.67^{**}$); hand length ($r=0.66^{**}$); elbow height ($r=0.64^{**}$); waist height ($r=0.76^{**}$) and span ($r=0.85^{**}$) indicating that with an increase in selected static anthropometric measurements there was increase in vertical upward arm reach of women. Regression coefficient indicated that one cm increase in standing height, mid-shoulder height, hand length, elbow height, waist height and span increased vertical upward arm reach of women by 1.23, 0.81, 1.30, 1.00, 1.35 and 0.99 cm respectively.

Table 9 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Vertical Upward Arm Reach (D_1) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.87^{**}	0.75	D_1=7.67+1.23 S_1
Mid Shoulder Height (S_4)	0.67^{**}	0.45	D_1=87.98+0.81S_4
Hand Length (S_5)	0.66^{**}	0.43	D_1=104.8+1.30 S_5
Elbow Height (S_8)	0.64^{**}	0.41	D_1=95.86+1.00 S_8
Waist Height (S_{10})	0.76^{**}	0.58	D_1=66.63+1.35 S_{10}
Span (S_{14})	0.85^{**}	0.72	D_1=37.23+0.99 S_{14}

** Significant at 1% level of significance

The values of coefficient of determination indicated that the per cent effect of normal standing height (75%) was more followed by span (72%) on vertical upward arm reach of women. Waist height exhibited 58 per cent effect on vertical upward arm reach of women.

4.4.1.2 The Multiple Regression Model of Vertical Upward Arm Reach of Women With Standing Static Anthropometry

The multiple regression model of vertical upward arm reach of women with standing static anthropometry is presented in Table 10.

It is apparent from the Table that the set of static anthropometric measurements included in regression analysis could explain the variation in vertical upward arm reach to the extent of 83 per cent. (R^2= 0.83). ‘F’ value (412.61^{**}) was found to be significant at 1 per cent level of significance. Normal standing height ($t=10.1^{**}$), hand length ($t=3.33^{**}$), waist height ($t=3.17^{**}$) and span ($t=10.72^{**}$) contributed positively and significantly to the vertical upward arm reach of women. Partial regression coefficient indicated that one centimeter increase each in normal standing height, hand length, waist height and span resulted in an increase in vertical upward arm reach by 0.59, 0.19, 0.17, 0.43 cm respectively.

Table 10 The Multiple Regression Model of Vertical Upward Arm Reach (D_1) of Women With Standing Static Anthropometry

Anthropometric Variables	**Partial Regression Coefficient (b_i)**	**SE (b_i)**	**t (b_i)**
Normal Standing Height (S_1)	0.59	0.06	10.10**
Mid Shoulder Height (S_4)	-0.002	0.04	-0.62NS
Hand Length (S_5)	0.19	0.06	3.33**
Elbow Height (S_8)	0.07	0.04	1.75NS
Waist Height (S_{10})	0.17	0.12	3.17**
Span (S_{14})	0.43	0.04	10.72**

B_0= 2.07 R^2=0.83 F=412.61**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non-significant

4.4.1.3 Path Analysis Between Standing Static Anthropometry and Vertical Upward Arm Reach of Women

Path analysis between selected standing static anthropometry and vertical upward arm reach of women is presented in Table 11 and illustrated in Figure 10.

It is clear from the Table that the total effect of selected static anthropometry of women on vertical upward arm reach was significant and positive. The direct effect of normal standing height of women was positive and more (0.42) followed by span of women (0.37) on vertical upward arm reach of women in standing position. It was noticed that normal standing height (0.45), mid-shoulder height (0.69), hand length (0.56), elbow height (0.60), waist height

(0.66) and span (0.48) contributed indirectly and substantially more than direct effect on vertical upward arm reach of women.

Table 11 Path Analysis Between Standing Static Anthropometry and Vertical Upward Arm Reach (D_1) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.87	0.42	0.45	0.29(S_{14})	0.08(S_{10})
Mid-Shoulder Height (S_4)	0.67	-0.02	0.69	0.30(S_1)	0.22(S_{14})
Hand Length (S_5)	0.66	0.1	0.56	0.25(S_1)	0.24(S_{14})
Elbow Height (S_8)	0.64	0.04	0.60	0.29(S_1)	0.20(S_{14})
Waist Height (S_{10})	0.76	0.1	0.66	0.33(S_1)	0.26(S_{14})
Span (S_{14})	0.85	0.37	0.48	0.33(S_1)	0.07(S_{10})

The indirect effect of normal standing height (0.29) via span was found to be substantial on vertical upward arm reach of women via span while mid-shoulder height (0.30), hand length (0.25), elbow height (0.29), waist height (0.33) and span (0.33) of women on vertical upward arm reach of women via normal standing height was substantial and positive.

Overall it can be said that normal standing height and span are important static anthropometric measurements affecting significantly the vertical upward arm reach of women in standing position.

4.4.2 Relationship Between Standing Static Anthropometric Measurements and Vertical Upward Grasp Reach

4.4.2.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Vertical Upward Grasp Reach of Women

Simple correlation and regression analysis between standing static anthropometry and vertical upward grasp reach of women is recorded in Table 12 and explained in Figure 11.

It is clear from Table that vertical upward grasp reach was significantly and positively correlated with normal standing height ($r=0.86^{**}$), mid-shoulder height ($r=0.66^{**}$), hand length ($r=0.63^{**}$), elbow height ($r=0.54^{**}$), waist height ($r=0.73^{**}$) and span ($r=0.82^{**}$) indicating that the vertical upward grasp reach was found to be increased with an increase in selected set of static anthropometric measurements of women.

Regression analysis indicated that 1 cm increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span caused 1.5 cm, 0.76 cm, 1.19 cm, 0.91 cm, 1.24 cm and 0.91cm increase in vertical upward grasp reach of women in standing position respectively. Normal standing height ($r^2=0.74$) and span ($r^2 = 0.67$) expressed more effect on vertical upward grasp reach of women. Mid-shoulder height and waist height revealed 43 per cent and 53 per cent effect on vertical upward grasp reach of women.

Table 12 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Vertical Upward Grasp Reach (D_2) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.86^{**}	0.74	$D_2=11.63+1.15S_1$
Mid Shoulder Height (S_4)	0.66^{**}	0.43	$D_2=87.12+0.76S_4$
Hand Length (S_5)	0.63^{**}	0.39	$D_2=104.9+1.19S_5$
Elbow Height (S_8)	0.54^{**}	0.29	$D_2=96.37+0.91S_8$
Waist Height (S_{10})	0.73^{**}	0.53	$D_2=69.39+1.24S_{10}$
Span (S_{14})	0.82^{**}	0.67	$D_2=42.40+0.91S_{14}$

** Significant at 1% level of significance

4.4.2.2 The Multiple Regression Model of Vertical Upward Grasp Reach of Women With Standing Static Anthropometry

The Multiple Regression Model of vertical upward grasp reach of women with standing static anthropometry is noted in Table 13

It is evident that set of static anthropometric measurements included in regression analysis could explain the variation in vertical upward grasp reach to the extent of 79 per cent (R^2=0.79) with significant 'F' value of 315.28. Normal standing height ($t=10.54^{**}$), hand length ($t=2.34^{**}$), waist height ($t= 2.09^{*}$) and span ($t=8.56^{**}$) contributed significantly and positively to the vertical upward grasp reach of women.

Table 13 The Multiple Regression Model of Vertical Upward Grasp Reach (D_2) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.65	0.06	10.54**
Mid Shoulder Height (S_4)	0.001	0.04	0.20NS
Hand Length (S_5)	0.14	0.06	2.34*
Elbow Height (S_8)	0.02	0.04	0.61NS
Waist Height (S_{10})	0.12	0.13	2.09*
Span (S_{14})	0.36	0.048	8.56**

B_0= 7.18 R^2= 0.79 F=315.28**

** Significant at 1% level of significance * Significant at 5% level of significance

NS Non-significant

The values of partial regression coefficient indicated that one-centimeter increase in normal standing height resulted in increase of 0.65 cm in vertical upward grasp reach of women. The vertical upward grasp reach of women increased by 0.36 cm with an increase of one cm in span of women. A meager increase of 0.14 and 0.12 cm was noticed in vertical upward grasp reach with an increase of 1 cm in hand length and waist height respectively.

4.4.2.3 Path Analysis Between Standing Static Anthropometry and Vertical Upward Grasp Reach of Women

Path analysis between selected standing static anthropometry and vertical upward grasp reach of women is presented in Table 14 and depicted in Figure 12

It is clear from the Table that the total correlation of selected static measurements of women with vertical upward grasp reach was significant and positive. The highest positive total effect was exercised by normal standing height (0.86) followed by span (0.82) and waist height of women (0.73) on vertical upward grasp reach of women in standing position. The effect of mid-shoulder height (0.66), hand length (0.63) and elbow height (0.54) on vertical upward grasp reach of women was between 0.54 and 0.66.

Table 14 Path Analysis Between Standing Static Anthropometry and Vertical Upward Grasp Reach (D_2) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.86	0.48	0.38	0.26(S_{14})	0.05(S_{10})
Mid Shoulder Height (S_4)	0.66	0.001	0.66	0.35(S_1)	0.20(S_{14})
Hand Length (S_5)	0.63	0.08	0.55	0.28(S_1)	0.22(S_{14})
Elbow Height (S_8)	0.54	0.01	0.53	0.29(S_1)	0.16(S_{14})
Waist Height (S_{10})	0.73	0.07	0.66	0.38(S_1)	0.23(S_{14})
Span (S_{14})	0.82	0.33	0.49	0.38(S_1)	0.05(S_5)

The effect of normal standing height (0.48) was direct, more and positive on vertical upward grasp reach whereas, the effect of mid-shoulder height (0.66), hand length (0.55), elbow height (0.53), waist height (0.66) and span (0.49) was indirect, positive and substantial on vertical upward grasp reach of women in standing position.

The indirect effect of normal standing height on vertical upward grasp reach via span (0.26) was found to be positive and substantial. The effect of mid-shoulder height (0.35), hand length (0.28), elbow height (0.29), waist height (0.38) and span (0.38) of women on vertical upward grasp reach of women was substantial and positive via normal standing height.

Hence, it can be concluded that normal standing height and span are important static anthropometric measurements affecting significantly vertical upward grasp reach of women in standing position.

4.4.3 Relationship Between Standing Static Anthropometric Measurements and Upper Position Arm Reach Height of Women

4.4.3.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Upper Position Arm Reach Height of Women

Simple correlation and regression analysis between standing static anthropometry and upper position arm reach height of women is reported in Table 15 and Figure 13.

It is clear from the Table that the upper position arm reach height of women was positively correlated with normal standing height ($r=0.76^{**}$), mid-shoulder height ($r=0.60^{**}$), hand length ($r=0.61^{**}$), elbow height ($r=0.60^{**}$), waist height ($r=0.74^{**}$) and span ($r=0.74^{**}$) of women indicating that the increase in upper position arm reach height of women was directly associated with an increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span of women in standing position. The values of 'r' square indicated approximately equal percentage effect of normal standing height, waist height and span ($r^2=0.55$ to 0.58) on upper position arm reach height of women. The percentage range of 36 and 37 was observed for the effect of mid-shoulder height, hand length and elbow height on upper position arm reach height of women.

Regression coefficient indicated that one cm increase in normal standing height; hand length and waist height increased upper position arm reach height of women by 1.12 cm, 1.25 cm and 1.35 cm respectively. Increase of 0.75 cm, 0.96 cm and 0.90 cm in upper position arm reach height was noticed with an increase of 1 cm in mid-shoulder height, elbow height and span of women respectively.

Table 15 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Upper Position Arm Reach Height (D_6) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Normal Standing Height (S_1)	0.76^{**}	0.58	D_6=17.2+1.12S_1
Mid Shoulder Height (S_4)	0.60^{**}	0.36	D_6=88.35+0.75S_4
Hand Length (S_5)	0.61^{**}	0.37	D_6=100.6+1.25S_5
Elbow Height (S_8)	0.60^{**}	0.36	D_6=91.68+0.96S_8
Waist Height (S_{10})	0.74^{**}	0.55	D_6=58.44+1.35S_{10}
Span (S_{14})	0.74^{**}	0.55	D_6=45.13+0.90S_{14}

** Significant at 1% level of significance

4.4.3.2 The Multiple Regression Model of Upper Position Arm Reach Height of Women With Standing Static Anthropometry

The multiple regression model of upper position arm reach height of women with standing static anthropometry is presented in Table 16

It is clear from the Table that the selected set of static anthropometry could explain the variation in upper position arm reach height by 68 per cent. Normal standing height ($t=4.51^{**}$) and hand length ($t=3.76^{**}$), elbow height ($t=2.14^{*}$), waist height ($t=6.26^{**}$) and span ($t=5.05^{**}$) contributed significantly and positively to the upper position height with partial regression coefficient of 0.38, 0.31, 0.13, 0.49 and 0.29 respectively. This explains that one centimeter increase in normal standing height having other variables constant can cause 0.38 cm increase in upper position arm reach height while 0.31 cm increase in upper position arm reach height was explained with an increase of 1 cm in hand length keeping all other measurements at constant. The respective increase of 0.13cm, 0.49cm and 0.29cm in upper position arm reach height was found with an increase of 1 cm in elbow height, waist height and span of women.

Table 16 The Multiple Regression Model of Upper Position Arm Reach Height (D_6) of Women With Standing Static Anthropometry

Anthropometric Variables	**Partial Regression Coefficient (b_i)**	**SE (b_i)**	**t (b_i)**
Normal Standing Height (S_1)	0.38	0.08	4.51^{**}
Mid Shoulder Height (S_4)	-0.08	0.05	-1.38NS
Hand Length (S_5)	0.31	0.08	3.76^{**}
Elbow Height (S_8)	0.13	0.06	2.14^{*}
Waist Height (S_{10})	0.49	0.08	6.26^{**}
Span (S_{14})	0.29	0.06	5.05^{**}

$B_0=12.52$ $R^2=0.68$ $F=175.71^{**}$

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.4.3.3 Path Analysis Between Standing Static Anthropometry and Upper Position Arm Reach Height of Women

Path analysis between selected standing static anthropometry and upper position arm reach height is noted in Table 17 and Figure 14

The total effect of selected static anthropometry on upper position arm reach height was substantial, positive and significant. Normal standing height (0.76) showed maximum total effect on upper position height followed by equal effect of waist height (0.74) and span (0.74). Approximately equal total effect of mid-shoulder height (0.60); hand length (0.61) and elbow height (0.60) was recorded on upper position arm reach height of women in standing position.

Table 17 Path Analysis Between Standing Static Anthropometry and Upper Position Arm Reach Height (D_6) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.76	0.26	0.50	0.21(S_{10})	0.19(S_{14})
Mid Shoulder Height (S_4)	0.60	-0.06	0.66	0.19(S_1)	0.17(S_{10})
Hand Length (S_5)	0.61	0.15	0.46	0.16(S_{14})	0.15(S_1)
Elbow Height (S_8)	0.60	0.08	0.52	0.18(S_1)	0.17(S_{10})
Waist Height (S_{10})	0.74	0.27	0.47	0.20(S_1)	0.17(S_{14})
Span (S_{14})	0.74	0.24	0.50	0.21(S_1)	0.19(S_{10})

All the selected static anthropometric measurements like normal standing height (0.50), mid-shoulder height (0.66), hand length (0.46), elbow height (0.52), waist height (0.47) and span (0.50) exhibited positive, indirect and substantial effect on upper position arm reach height of women in standing position. Substantial indirect effect of normal standing height on upper position arm reach height of women was more through waist height (0.21) followed by span (0.19) of women.

The indirect effect of mid-shoulder height (0.19), elbow height (0.18) and span (0.21) was noticed on upper position arm reach height of women through normal standing height followed by waist height. The indirect effect of waist height on upper position arm reach height was observed through normal standing height (0.20) and span (0.17) of women.

4.4.4 Relationship Between Standing Static Anthropometric Measurements and Mid Position Arm Reach Height of Women

4.4.4 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Mid Position Arm Reach Height of Women

Simple correlation and regression analysis between standing static anthropometry and mid position arm reach height of women is reported in Table 18 and illustrated in Figure 15.

It is evident from the Table that the mid position arm reach height of women was positively correlated with normal standing height ($r=0.73^{**}$), mid-shoulder height ($r=0.58^{**}$), hand length ($r=0.51^{**}$), elbow height ($r=0.59^{**}$), waist height ($r=0.67^{**}$) and span ($r=0.67^{**}$) of women which indicated that the increase in middle position arm reach height of women was directly associated with increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span of women in standing position.

Table 18 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Mid Position Arm Reach Height (D_7) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.73^{**}	0.53	D_7=32.32+0.63S_1
Mid Shoulder Height (S_4)	0.58^{**}	0.33	D_7=72.51+0.43 S_4
Hand Length (S_5)	0.51^{**}	0.26	D_7=86.24+0.62 S_5
Elbow Height (S_8)	0.59^{**}	0.35	D_7=72.81+0.57 S_8
Waist Height (S_{10})	0.67^{**}	0.45	D_7=59.41+0.73 S_{10}
Span (S_{14})	0.67^{**}	0.45	D_7=53.18+0.48 S_{14}

** Significant at 1% level of significance

The values of ‘r’ square indicated 53 per cent effect of normal standing height on mid position arm reach height followed by 45 per cent effect of waist height and span, (r^2=0.45). The percentage range of 26, 33 and 35 was observed for the effect of hand length, mid-shoulder height and elbow height on mid position height of women.

Regression coefficient indicated that one cm increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span increased middle position height of women by 0.63 cm, 0.43cm, 0.62cm, 0.57cm, 0.73cm and 0.48cm respectively.

4.4.4.2 The Multiple Regression Model of Mid Position Arm Reach Height (D_7) of Women With Standing Static Anthropometry

The multiple regression model of mid position arm reach height of women with standing static anthropometry is presented in Table 19.

It is clear from the Table that the selected set of static anthropometry could explain the variation in mid position arm reach height by 58 per cent. Normal standing height (t=4.86**), elbow height (t=2.93**), waist height (t=3.68**) and span (t=3.51**) contributed significantly and positively to the mid position arm reach height with partial regression coefficient of 0.28, 0.12, 0.2, and 0.14 respectively. This explains that one centimeter increase in normal standing height having other variables constant can cause 0.28 cm increase in mid position arm reach height of women while 0.2 cm increase in mid position arm reach height was recorded with an increase of 1 cm in waist height keeping all other measurements at constant. The respective increase of 0.12cm, and 1.14cm in mid position arm reach height was noticed with an increase of 1 cm in elbow height, waist height and span of women respectively.

Table 19 The Multiple Regression Model of Mid Position Arm Reach Height (D_7) of Women With Standing Static Anthropometry

Anthropometric Variables	**Partial Regression Coefficient (b_i)**	**SE (b_i)**	**t (b_i)**
Normal Standing Height (S_1)	0.28	0.06	4.86**
Mid Shoulder Height (S_4)	0.02	0.04	0.66NS
Hand Length (S_5)	0.005	0.06	0.09NS
Elbow Height (S_8)	0.12	0.04	2.93**
Waist Height (S_{10})	0.20	0.05	3.68**
Span (S_{14})	0.14	0.04	3.51**

B_0= 30.34 R^2=0.58 F=113.41**

** Significant at 1% level of significance NS Non significant

4.4.4.3 Path Analysis Between Standing Static Anthropometry and Mid Position Arm Reach Height of Women

Path analysis between selected standing static anthropometry and mid position arm reach height of women is reported in Table 20 and depicted in Figure 16.

It is obvious from the Table that the total effect of normal standing height (0.73), mid-shoulder height (0.58), hand length (0.51), elbow height (0.59), waist height (0.67) and span (0.67) on mid position arm reach height of women was positive and significant. The distribution of direct and indirect effect of normal standing height (0.41), mid-shoulder height (0.55), hand length (0.51), elbow height (0.47), waist height (0.49) and span (0.48) on mid position arm reach height of women showed that these variables were having more indirect effect on mid position arm reach height of women in standing position than direct effect.

Table 20 Path Analysis Between Standing Static Anthropometry and Mid Position Arm Reach Height (D_7) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect(I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.73	0.32	0.41	0.15(S_{14})	0.14(S_{10})
Mid Shoulder Height (S_4)	0.58	0.03	0.55	0.23(S_1)	0.12(S_{14})
Hand Length (S_5)	0.51	0.004	0.51	0.19(S_1)	0.13(S_{14})
Elbow Height (S_8)	0.59	0.12	0.47	0.22(S_1)	0.11(S_{10})
Waist Height (S_{10})	0.67	0.18	0.49	0.25(S_1)	0.13(S_{14})
Span (S_{14})	0.67	0.19	0.48	0.26(S_1)	0.13(S_{10})

Substantial indirect effect of selected static measurements on mid position arm reach height of women indicated that normal standing height was having indirect effect on mid position arm reach height through span (0.15) and waist height (0.14). Whereas, mid-shoulder height (0.23, 0.12); hand length (0.19, 0.13) and waist height (0.25, 0.13) showed indirect effect on mid position arm reach height via normal standing height and span of women. The indirect effect of elbow height (0.22, 0.11) and span (0.26, 0.13) was recorded on mid position arm reach height of women through normal standing height and waist height of women in standing position.

4.4.5 Relationship Between Standing Static Anthropometric Measurements and Lower Position Arm Reach Height of Women

4.4.5.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Lower Position Arm Reach Height of Women

Simple correlation and regression analysis between standing static anthropometry and lower position arm reach height of women is presented in Table 21 and depicted in Figure 17.

It is evident from the Table that the lower position arm reach height of women was positively correlated with normal standing height ($r=0.34^{**}$), mid-shoulder height ($r=0.21^{**}$), elbow height ($r=0.16^{**}$), waist height ($r=0.19^{**}$) and span ($r=0.21^{**}$) of women which indicated that the increase in lower position arm reach height of women was directly associated with increase in normal standing height, mid-shoulder height, elbow height, waist height and span of women in standing position.

Table 21 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Lower Position Arm Reach Height (D_8) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.34**	0.11	D_8=15.36+0.34 S_1
Mid Shoulder Height (S_4)	0.21**	0.04	D_8=43.64+0.18 S_4
Hand Length (S_5)	0.04NS	0.001	D_8=63.15+0.06 S_5
Elbow Height (S_8)	0.16**	0.02	D_8=49.88+0.18 S_8
Waist Height (S_{10})	0.19**	0.03	D_8=44.93+0.24 S_{10}
Span (S_{14})	0.21**	0.04	D_8=40.07+0.17 S_{14}

** Significant at 1% level of significance

The values of 'r' square indicated meager effect of normal standing height (11 %), on lower position arm reach height followed by 2 to 4 per cent effect of mid-shoulder height, elbow height, waist height and span of women.

Regression coefficient indicated that one cm increase in normal standing height, mid-shoulder height, elbow height, waist height and span increased lower position arm reach height of women by 0.34 cm, 0.18cm, 0.18cm, 0.24cm, and 0.17cm respectively.

4.4.5.2 The Multiple Regression Model of Lower Position Arm Reach Height of Women With Standing Static Anthropometry

The multiple regression model of lower position arm reach height of women with standing static anthropometry is presented in Table 22.

It is clear from the Table that the selected set of static anthropometry could explain the variation in lower position arm reach height by 17 per cent. Normal standing height ($t=6.49^{**}$) contributed significantly and positively to the lower position height with partial regression coefficient of 0.61. This explains that one centimeter increase in normal standing height having other variables constant can cause 0.61 cm increase in lower position arm reach height of women. Hand length ($t=-3.92^{**}$), elbow height ($t=-1.97^{*}$) and waist height ($t=-1.96^{*}$) contributed significantly and negatively to lower position arm reach height of women. Partial regression coefficient explained that the one centimeter increase in hand length, elbow height and waist height revealed decrease in lower position arm reach height by 0.36, 0.13 and 0.17 cm respectively.

Table 22 The Multiple Regression Model of Lower Position Arm Reach Height (D_8) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.61	0.09	6.49^{**}
Mid Shoulder Height (S_4)	0.11	0.06	1.78NS
Hand Length (S_5)	-0.36	0.09	-3.92^{**}
Elbow Height (S_8)	-0.13	0.06	-1.97^{*}
Waist Height (S_{10})	-0.17	0.09	-1.96^{*}
Span (S_{14})	0.02	0.06	-0.25NS

$B_0=17.41$ $R^2=0.17$ $F=16.79^{**}$

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.4.5.3 Path Analysis Between Standing Static Anthropometry and Lower Position Arm Reach Height of Women

Path analysis between selected standing static anthropometry and lower position arm reach height of women is presented in Table 23 and illustrated in Figure 18.

It is clear from the Table that the direct effect of normal standing height of women was positive and more (0.60) on lower position arm reach height of women in standing position than the direct effect of mid-shoulder height (0.13). Hand length (-0.26), elbow height (-0.12), waist height (-0.14) and span (-0.02) contributed negatively with lower position height of women. As seen by indirect effect elbow height (0.28), hand length (0.30), waist height (0.33) and span (0.25) contributed indirectly and substantially on lower position arm reach height of women in standing position.

Table 23 Path Analysis Between Standing Static Anthropometry and Lower Position Arm Reach Height (D_8) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.34	0.60	-0.26	-0.15(S_5)	-0.11(S_{10})
Mid Shoulder Height (S_4)	0.21	0.13	0.08	0.44(S_1)	-0.19(S_5)
Hand Length (S_5)	0.04	-0.26	0.30	0.36(S_1)	0.09(S_4)
Elbow Height (S_8)	0.16	-0.12	0.28	0.42(S_1)	-0.12(S_5)
Waist Height (S_{10})	0.19	-0.14	0.33	0.47(S_1)	-0.14(S_5)
Span (S_{14})	0.21	-0.02	0.23	0.48(S_1)	-0.17(S_5)

The indirect effect of mid-shoulder height (0.44), elbow height (0.42), hand length (0.36), waist height (0.47) and span (0.48) of women on lower position arm reach height via normal standing height was substantial and positive whereas, the indirect effect of normal standing height on lower position height of women via hand length was less and negative (-0.15).

Overall it can be inferred that normal standing height and hand length are important static anthropometric measurements affecting lower position arm reach height of women in standing position.

4.4.6 Relationship Between Standing Static Anthropometric Measurements and Upper Position Grasp Reach Height of Women

4.4.6.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Upper Position Grasp Reach Height of Women

Correlation and regression analysis between standing static anthropometry and upper position grasp reach height of women is presented in Table 24 and Figure 19.

It is evidenced from the Table that the upper position grasp reach height of women was positively correlated with normal standing height ($r=0.72^{**}$), mid-shoulder height ($r=0.57^{**}$), hand length ($r=0.58^{**}$), elbow height ($r=0.59^{**}$), waist height ($r=0.71^{**}$) and span ($r=0.71^{**}$) of women indicating that the increase in upper position grasp reach height of women was directly associated with increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span of women in standing position.

Table 24 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Upper Position Grasp Reach Height (D_9) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.72**	0.52	D_9=14.88+1.09 S_1
Mid Shoulder Height (S_4)	0.57**	0.32	D_9=84.37+0.73 S_4
Hand Length (S_5)	0.58**	0.33	D_9=95.45+1.23 S_5
Elbow Height (S_8)	0.59**	0.35	D_9=82.44+0.99 S_8
Waist Height (S_{10})	0.71**	0.50	D_9=51.70+1.35 S_{10}
Span (S_{14})	0.71**	0.50	D_9=41.71+0.88 S_{14}

** Significant at 1% level of significance

The values of ‘r’ square indicated approximately equal percentage effect of normal standing height; waist height and span (r^2=0.50 to 0.52) on upper position grasp reach height of women. The percentage range of 32, 33 and 37 was observed for the effect of mid-shoulder height, hand length and elbow height on upper position grasp reach height of women.

Regression coefficient indicated that one cm increase in normal standing height; hand length and waist height increased upper position grasp reach height of women by 1.09 cm, 1.23cm and 1.35 cm respectively. The increase of 0.73cm, 0.99cm and 0.88cm in upper position grasp reach height was noticed with an increase of 1 cm in mid-shoulder height, elbow height and span of women respectively.

4.4.6.2 The Multiple Regression Model of Upper Position Grasp Reach Height of Women With Standing Static Anthropometry

The multiple regression model of upper position grasp reach height of women with standing static anthropometry is presented in Table 25.

It is clear from the Table that the selected set of static anthropometry could explain the variation in upper position height by 65 per cent. Normal standing height (t=2.78*), hand length (t=2.54*), elbow height (t=2.45*), waist height (t=3.12**) and span (t=2.78**) contributed significantly and positively to the upper position grasp reach height with corresponding partial regression coefficient of 0.29,0.32,0.21,0.55 and 0.27.

Table 25 The Multiple Regression Model of Upper Position Grasp Reach Height (D_9) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.29	0.09	2.78*
Mid Shoulder Height (S_4)	-0.11	0.06	-1.19NS
Hand Length (S_5)	0.32	0.09	2.54*
Elbow Height (S_8)	0.21	0.06	2.45*
Waist Height (S_{10})	0.55	0.18	3.12**
Span (S_{14})	0.27	0.07	2.78**

B_0=10.07 R^2=0.65 F=137.85**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

Partial regression coefficient explains that one centimeter increase in normal standing height having other variables constant can cause 0.29 cm increase in upper position grasp reach height whereas, 0.32 cm increase in upper position grasp reach height was recorded with an increase of 1 cm in hand length keeping all other measurements at constant. The respective increase of 0.21cm, 0.55cm and 0.27cm in upper position height was noticed with an increase of 1 cm in elbow height, waist height and span of women.

4.4.6.3 Path Analysis Between Standing Static Anthropometry and Upper Position Grasp Reach Height of Women

Path analysis between selected standing static anthropometry and upper position grasp reach height of women is reported in Table 26 and depicted through Figure 20.

The total effect of selected static anthropometry on upper position grasp reach height was substantial, positive and significant. Normal standing height (0.72) showed maximum total effect on upper position grasp reach height followed by equal effect of waist height (0.71) and span (0.71). Approximately equal total effect of mid-shoulder height (0.57); hand length (0.58) and elbow height (0.59) was recorded on upper position grasp reach height of women in standing position.

Table 26 Path Analysis Between Standing Static Anthropometry and Upper Position Grasp Reach Height (D_9) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.72	0.19	0.53	0.23(S_{10})	0.18(S_{14})
Mid Shoulder Height (S_4)	0.57	-0.08	0.65	0.18(S_{10})	0.14(S_1)
Hand Length (S_5)	0.58	0.15	0.43	0.16(S_{10})	0.15(S_{14})
Elbow Height (S_8)	0.59	0.13	0.46	0.18(S_{10})	0.13(S_1)
Waist Height (S_{10})	0.71	0.29	0.42	0.16(S_{14})	0.15(S_1)
Span (S_{14})	0.71	0.22	0.49	0.21(S_{10})	0.15(S_1)

All the selected static anthropometric measurements like normal standing height (0.53), mid-shoulder height (0.65), hand length (0.43), elbow height (0.46), waist height (0.42) and span (0.49) exhibited positive, indirect and substantial effect on upper position grasp reach height of women in standing position. Substantial indirect effect of normal standing height on upper position grasp reach height of women was more through waist height (0.23) followed by span (0.18) of women.

The indirect effect of mid-shoulder height (0.18), elbow height (0.18) and span (0.21) was noticed on upper position grasp reach height of women through waist height followed by normal standing height. The indirect effect of waist height on upper position grasp reach height was observed through span (0.16) and normal standing height (0.15) of women.

It can be inferred from above analysis that normal standing height, shoulder height and span contribute in determination of upper position grasp reach height of women.

4.4.7 Relationship Between Standing Static Anthropometric Measurements and Mid Position Grasp Reach Height of Women

4.4.7.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Mid Position Grasp Reach Height of Women

Simple correlation and regression analysis between standing static anthropometry and mid position grasp reach height is reported in Table 27 and illustrated in Figure 21.

It is evident from the Table that the mid position grasp reach height of women was positively correlated with normal standing height ($r=0.52^{**}$), Mid-shoulder height ($r=0.40^{**}$), hand length ($r=0.35^{**}$), elbow height ($r=0.45^{**}$), waist height ($r=0.52^{**}$) and span ($r=0.46^{**}$) of women which indicated that the increase in mid position grasp reach height of women was directly associated with increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span of women in standing position.

Table 27 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Mid Position Grasp Reach Height (D_{10}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Normal Standing Height (S_1)	0.52^{**}	0.27	$D_{10}=41.76+0.58\ S_1$
Mid Shoulder Height (S_4)	0.40^{**}	0.16	$D_{10}=78.62+0.38\ S_4$
Hand Length (S_5)	0.35^{**}	0.12	$D_{10}=91.82+0.54\ S_5$
Elbow Height (S_8)	0.45^{**}	0.20	$D_{10}=74.73+0.55\ S_8$
Waist Height (S_{10})	0.52^{**}	0.27	$D_{10}=60.13+0.73\ S_{10}$
Span (S_{14})	0.46^{**}	0.21	$D_{10}=62.01+0.43\ S_{14}$

** Significant at 1% level of significance

The values of 'r' square indicated 27 per cent effect of normal standing height and waist height on mid position grasp reach height of women followed by 21 per cent effect of span. The percentage range of 20, 16 and 12 was observed for the effect of elbow height; mid-shoulder height and hand length on mid position grasp reach height of women.

Regression coefficient indicated that one cm increase in normal standing height, mid-shoulder height, hand length elbow height, waist height and span increased mid position grasp reach height of women by 0.58 cm, 0.38 cm, 0.54 cm, 0.55 cm, 0.73 cm and 0.43 cm respectively.

4.4.7.2 The Multiple Regression Model of Mid Position Grasp Reach Height of Women With Standing Static Anthropometry

The multiple regression model of mid position grasp reach height of women with standing static anthropometry is presented in Table 28.

It is clear from the Table that the selected set of static anthropometry could explain the variation in mid position grasp reach height by 31 per cent. Elbow height ($t=2.46^{**}$) and waist height ($t=4.05^{**}$) contributed significantly and positively to the mid position grasp reach height with partial regression coefficient of 0.16 and 0.36 respectively.

Table 28 The Multiple Regression Model of Mid Position Grasp Reach Height (D_{10}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.17	0.09	1.80NS
Mid Shoulder Height (S_4)	0.005	0.06	0.08NS
Hand Length (S_5)	-0.02	0.09	-0.26NS
Elbow Height (S_8)	0.16	0.06	2.46^{*}
Waist Height (S_{10})	0.36	0.09	4.05^{**}
Span (S_{14})	0.09	0.06	1.40NS

$B_0=40.36$ $R^2=0.31$ $F=37.48^{**}$

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

The partial regression coefficient explains that one centimeter increase in elbow height having other variables constant can cause 0.16 cm increase in mid position grasp reach height of women while 0.36 cm increase in mid position height was explained with an increase of 1 cm in waist height keeping all other measurements at constant.

4.4.7.3 Path Analysis Between Standing Static Anthropometry and Mid Position Grasp Reach Height of Women

Path analysis between selected standing static anthropometry and mid position grasp reach height is depicted in Table 29 and Figure 22.

It is obvious from the Table that the total effect of normal standing height (0.52), mid-shoulder height (0.40), hand length (0.35), elbow height (0.45), waist height (0.52) and span (0.46) on mid position grasp reach height of women was positive and significant.

Table 29 Path Analysis Between Standing Static Anthropometry and Mid Position Grasp Reach Height (D_{10}) of Women

Anthropometric Variables	**Total Effect**	**Direct Effect**	**Indirect Effect**	**Substantial Indirect Effect (I)**	**Substantial Indirect Effect (II)**
Normal Standing Height (S_1)	0.52	0.15	0.37	0.20(S_{10})	0.15(S_1)
Mid Shoulder Height (S_4)	0.40	0.01	0.39	0.16(S_{10})	0.11(S_1)
Hand Length (S_5)	0.35	-0.02	0.37	0.14(S_{10})	0.09(S_1)
Elbow Height (S_8)	0.45	0.13	0.32	0.16(S_{10})	0.11(S_1)
Waist Height (S_{10})	0.52	0.26	0.26	0.12(S_1)	0.08(S_8)
Span (S_{14})	0.46	0.10	0.36	0.18(S_{10})	0.12(S_1)

The distribution of direct and indirect effect of normal standing height (0.37), mid-shoulder height (0.39), hand length (0.37), elbow height (0.32), waist height (0.26) and span (0.36) on mid position grasp reach height of women revealed that these variables were having more indirect effect on mid position grasp reach height of women in standing position than direct effect.

Substantial indirect effect of selected static measurements on mid position grasp reach height of women indicated that normal standing height was having indirect effect on mid position grasp reach height of women through waist height (0.20) and normal standing height (0.15) whereas, mid-shoulder height (0.16, 0.11); hand length (0.14, 0.09), elbow height (0.16, 0.11) and span (0.18, 0.12) showed indirect effect on mid position grasp reach height via waist height and normal standing height of women. The indirect effect of waist height (0.12, 0.08) was recorded on mid position grasp reach height of women through normal standing height and elbow height of women in standing position.

It can be concluded from the findings that normal standing height, waist height and elbow height substantially affect mid position grasp reach height of women in standing position.

4.4.8 Relationship Between Standing Static Anthropometric Measurements and Lower Position Grasp Reach Height of Women

4.4.8.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Lower Position Grasp Reach Height of Women

Simple correlation and regression analysis between standing static anthropometry and lower position grasp reach height of women in standing position is reported in Table 30 and illustrated in Figure 23.

It is evident from the Table that the lower position grasp reach height of women was positively correlated with normal standing height ($r=0.35^{**}$), mid-shoulder height ($r=0.22^{**}$), elbow height ($r=0.17^{**}$) and waist height ($r=0.20^{**}$) of women indicating that the increase in lower position grasp reach height of women was directly associated with increase in normal standing height, mid-shoulder height, elbow height and waist height of women in standing position. There was no correlation between lower position grasp reach height and hand length and span of women. The values of 'r' square indicated meager effect of normal standing height (12 %) on lower position grasp reach height followed by 3 to 5 % per cent effect of mid-shoulder height, elbow height and waist height of women. Regression coefficient indicated that one cm increase in normal standing height, mid-shoulder height, elbow height and waist height increased lower position grasp reach height of women by 0.38 cm, 0.20cm, 0.2cm and 0.28cm respectively.

Table 30 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Lower Position Grasp Reach Height (D_{11}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.35^{**}	0.94	D_{11}=16.92+0.38 S_1
Mid Shoulder Height (S_4)	0.22^{**}	0.16	D_{11}=48.21+0.20 S_4
Hand Length (S_5)	0.06NS	0.16	D_{11}=68.44+0.10 S_5
Elbow Height (S_8)	0.17^{**}	0.0009	D_{11}=54.93+0.20 S_8
Waist Height (S_{10})	0.20^{**}	0.17	D_{11}=48.81+0.28 S_{10}
Span (S_{14})	0.21^{**}	0.0004	D_{11}=44.42+0.19 S_{14}

** Significant at 1% level of significance NS Non significant

4.4.8.2 The Multiple Regression Model of Lower Position Grasp Reach Height of Women With Standing Static Anthropometry

The multiple regression model of lower position grasp reach height of women with standing static anthropometry is presented in Table 31

It is clear from the Table that the selected set of static anthropometry could explain the variation in lower position grasp reach height by 17 per cent. Normal standing height ($t=6.61^{**}$) contributed significantly and positively to the lower position grasp reach height with partial regression coefficient of 0.67.

Partial regression coefficient explains that one-centimeter increase in normal standing height having other variables constant can cause 0.67 cm increase in lower position grasp reach height of women. Hand length ($t=-3.45^{**}$) contributed significantly and negatively to lower position grasp reach height of women. Partial regression coefficient explained that one centimeter increase in hand length showed decrease in lower position grasp reach height by 0.35 cm.

Table 31 The Multiple Regression Model of Lower Position Grasp Reach Height (D_{11}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.67	0.10	6.61**
Mid Shoulder Height (S_4)	0.10	0.07	1.55NS
Hand Length (S_5)	-0.35	0.10	-3.45**
Elbow Height (S_8)	-0.14	0.07	-1.95NS
Waist Height (S_{10})	-0.17	0.09	-1.74NS
Span (S_{14})	-0.04	0.07	-0.54NS

B_0=19.16 R^2=0.17 F=16.86**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.4.8.3 Path Analysis Between Standing Static Anthropometry and Lower Position Grasp Reach Height of Women

Path analysis between selected standing static anthropometry and lower position grasp reach height was positive and significant except for hand length. The total correlation was divided into direct and indirect effect and is presented in Table 32 and in Figure 24.

It is clear from the Table that the direct effect of normal standing height of women was positive and more (0.61) on lower position grasp reach height of women in standing position than the indirect effect. Mid-shoulder height (0.11) was having equal indirect and direct effect on lower position grasp reach height of women in standing position. Hand length (-0.23), elbow height (-0.12), waist height (-0.12) and span (-0.04) contributed negatively with lower position grasp reach height of women. As expressed by indirect effect elbow height (0.29), hand length (0.29), waist height (0.32) and span (0.25) contributed indirectly and substantially on lower position grasp reach height of women in standing position.

The indirect effect of mid-shoulder height (0.44), elbow height (0.42), waist height (0.48) and span (0.49) of women on lower position grasp reach height via normal standing height was substantial and positive whereas, the indirect effect of normal standing height on lower position grasp reach height of women via hand length was less and negative (-0.15).

Table 32 Path Analysis Between Standing Static Anthropometry and Lower Position Grasp Reach Height (D_{11}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.35	0.61	-0.26	-0.14(S_5)	-0.10(S_{10})
Mid Shoulder Height (S_4)	0.22	0.11	0.11	0.44(S_1)	-0.16(S_5)
Hand Length (S_5)	0.06	-0.23	0.29	0.36(S_1)	0.08(S_4)
Elbow Height (S_8)	0.17	-0.12	0.29	0.42(S_1)	-0.11(S_5)
Waist Height (S_{10})	0.20	-0.12	0.32	0.48(S_1)	-0.13(S_5)
Span (S_{14})	0.21	-0.04	0.25	0.49(S_1)	-0.15(S_5)

In general it can be inferred that normal standing height and hand length are important static anthropometric measurements affecting lower position grasp reach height of women in standing position.

4.4.9 Relationship Between Standing Static Anthropometric Measurements and Forward Upper Position Arm Reach Height of Women

4.4.9.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Upper Position Arm Reach Height of Women

Simple correlation and regression analysis between standing static anthropometry and forward upper position arm reach height of women is reported in Table 33 and Figure 25.

It is evidenced from the Table that the forward upper position arm reach height of women was positively correlated with normal standing height ($r=0.65^{**}$), mid-shoulder height ($r=0.53^{**}$), hand length ($r=0.54^{**}$), elbow height ($r=0.55^{**}$), waist height ($r=0.67^{**}$) and span ($r=0.64^{**}$) of women which indicated that the increase in forward upper position arm reach height of women was directly associated with increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span of women in standing position. The values of 'r' square indicated approximately equal percentage effect of normal standing height (0.42); waist height (0.45) and span (0.41) on forward upper position arm reach height of women. The percentage range of 28-30 was observed for the effect of mid-shoulder height, hand length and elbow height on forward upper position arm reach height of women.

Regression coefficient indicated that one cm increase in normal standing height, hand length and waist height increased forward upper position arm reach height of women by 0.97cm, 1.13cm and 1.25 cm respectively. The increase of 0.68cm, 0.91cm and 0.79cm in forward upper position arm reach height was noticed with an increase of 1 cm in mid-shoulder height, elbow height and span of women respectively.

Table 33 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Upper Position Arm Reach Height (D_{18}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.65**	0.42	D_{18}=28.59+0.97 S_1
Mid Shoulder Height (S_4)	0.53**	0.28	D_{18}=86.18+0.68 S_4
Hand Length (S_5)	0.54**	0.29	D_{18}=97.58+1.13 S_5
Elbow Height (S_8)	0.55**	0.30	D_{18}=86.11+0.91 S_8
Waist Height (S_{10})	0.67**	0.45	D_{18}=57.07+1.25 S_{10}
Span (S_{14})	0.64**	0.41	D_{18}=50.41+0.79 S_{14}

** Significant at 1% level of significance

4.4.9.2 The Multiple Regression Model of Forward Upper Position Arm Reach Height of women With Standing Static Anthropometry

The multiple regression model of forward upper position arm reach height of women with standing static anthropometry is presented in Table 34

It is clear from the Table that the selected set of static anthropometry could explain the variation in forward upper position arm reach height by 53 per cent. Hand length (t=2.67**), elbow height (t=2.93**), waist height (t=6.03**) and span (t=3.77**) contributed significantly and positively to the forward upper position arm reach height with partial regression coefficient of 0.28, 0.21, 0.59 and 0.27.

The values of partial regression coefficient explained that one centimeter increase in hand length having other variables constant can cause 0.28 cm increase in forward upper position reach height whereas, 0.21 cm increase in forward upper position arm reach height was explained with an increase of 1 cm in elbow height keeping all other measurements at constant. The respective increase of 0.59 cm and 0.27cm in forward upper position arm reach height was explained with an increase of 1 cm in waist height and span of women.

Table 34 The Multiple Regression Model of Forward Upper Position Arm Reach Height (D_{18}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.11	0.10	1.11NS
Mid Shoulder Height (S_4)	-0.03	0.07	-0.53NS
Hand Length (S_5)	0.28	0.10	2.67**
Elbow Height (S_8)	0.21	0.07	2.93**
Waist Height (S_{10})	0.59	0.10	6.03**
Span (S_{14})	0.27	0.07	3.77**

B_0=23.84 R^2=0.53 F=92.66**

** Significant at 1% level of significance NS Non significant

4.4.9.3 Path Analysis Between Standing Static Anthropometry and Forward Upper Position Arm Reach Height of Women

Path analysis between selected standing static anthropometry and forward upper position arm reach height is indicated in Table 35 and Figure 26.

The total effect of selected static anthropometry on forward upper position arm reach height was substantial, positive and significant. Waist height (0.67) showed maximum total effect on forward upper position reach height followed by Normal standing height (0.65) and span (0.64). Approximately equal total effect of mid-shoulder height (0.53); hand length (0.54) and elbow height

(0.55) was recorded on forward upper position arm reach height of women in standing position.

Table 35 Path Analysis Between Standing Static Anthropometry and Forward Upper Position Arm Reach Height (D_{18}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.65	0.08	0.57	0.25(S_{10})	0.18(S_{14})
Mid Shoulder Height (S_4)	0.53	-0.03	0.56	0.20(S_{10})	0.13(S_{14})
Hand Length (S_5)	0.54	0.13	0.41	0.18(S_{10})	0.15(S_{14})
Elbow Height (S_8)	0.55	0.13	0.42	0.20(S_{10})	0.12(S_{14})
Waist Height (S_{10})	0.67	0.31	0.36	0.15(S_{14})	0.08(S_8)
Span (S_{14})	0.64	0.22	0.42	0.22(S_{10})	0.07(S_8)

All the selected static anthropometric measurements, like normal standing height (0.57), mid-shoulder height (0.56), hand length (0.41), elbow height (0.42), waist height (0.36) and span (0.42) exhibited positive, indirect and substantial effect on forward upper position reach height of women in standing position. Substantial indirect effect of normal standing height (0.25; 0.18), mid-shoulder height (0.20; 0.13), hand length (0.18; 0.15) and elbow height (0.20; 0.12) on forward upper position reach height of women was more through waist height followed by span of women. The indirect effect of waist height (0.15) was noticed on forward upper position arm reach height of women through span and the indirect effect of span on forward upper position arm reach height was observed through span (0.22) of women.

It is thus, concluded from the Table that waist height and span were the important static measurements in determining the forward upper position arm reach height of women in standing position.

4.4.10 Relationship Between Standing Static Anthropometric Measurements and Forward Mid Position Arm Reach Height of Women

4.4.10.1 Simple Correlation and Regression Analysis between Standing Static Anthropometry and Forward Mid Position Arm Reach Height of women

Simple Correlation and Regression Analysis between standing static anthropometry and forward mid position arm reach height of women is indicated in Table 36 and Figure 27.

It is evident from the Table that the forward mid position arm reach height of women was positively correlated with normal standing height ($r=0.50^{**}$), Mid-shoulder height ($r=0.40^{**}$), Hand length ($r=0.37^{**}$), elbow height ($r=0.45^{**}$), waist height ($r=0.52^{**}$) and span ($r=0.45^{**}$) of women Thus, indicated that the increase in forward mid position arm reach height of women was directly associated with increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span of women in standing position. The values of ‘r’ square indicated 25 per cent effect of normal standing height and 27 per cent effect of waist height on forward mid position arm reach height. The percentage range between 13 and 16 was observed for the effect of hand length and mid-shoulder height on forward middle position reach height of women. The percentage effect of elbow height and span of women was equal (20%) on forward mid position arm reach height of women.

Table 36 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Mid Position Arm Reach Height (D_{19}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Normal Standing Height (S_1)	0.50^{**}	0.25	D_{19}=45.91+0.52 S_1
Mid Shoulder Height (S_4)	0.40^{**}	0.16	D_{19}=78.17+0.36 S_4
Hand Length (S_5)	0.37^{**}	0.13	D_{19}=88.34+0.54 S_5
Elbow Height (S_8)	0.45^{**}	0.20	D_{19}=73.89+0.52 S_8
Waist Height (S_{10})	0.52^{**}	0.27	D_{19}=61.09+0.68 S_{10}
Span (S_{14})	0.45^{**}	0.20	D_{19}=64.15+0.39 S_{14}

** Significant at 1% level of significance

Regression coefficient indicated that one cm increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span increased forward mid position arm reach height of women by 0.63 cm, 0.43 cm, 0.62 cm, 0.57 cm, 0.73 cm and 0.48 cm respectively.

4.4.10.2 The Multiple Regression Model of Forward Mid Position Arm Reach Height of Women With Standing Static Anthropometry

The multiple regression model of forward mid position arm reach height of women with standing static anthropometry is presented in Table 37

It is clear from the Table that the selected set of static anthropometry could explain the variation in forward mid position arm reach height by 31 per cent. Elbow height ($t=2.88^{**}$) and waist height ($t=4.27^{**}$) contributed significantly and positively to the forward mid position arm reach height with partial regression coefficient of 0.18 and 0.35 respectively.

Table 37 The Multiple Regression Model of Forward Mid Position Arm Reach Height (D_{19}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.12	0.09	1.39NS
Mid Shoulder Height (S_4)	-0.01	0.06	-0.24NS
Hand Length (S_5)	0.06	0.09	0.74NS
Elbow Height (S_8)	0.18	0.06	2.88**
Waist Height (S_{10})	0.35	0.08	4.27**
Span (S_{14})	0.05	0.06	0.91NS

B_0= 44.44 R^2=0.31 F=36.91**

** Significant at 1% level of significance NS Non significant

This explains that one centimeter increase in elbow height having other variables constant can cause 0.18 cm increase in forward mid position arm reach height of women whereas, 0.35 cm increase in forward mid position arm reach height was explained with an increase of 1 cm in waist height keeping all other measurements at constant.

4.4.10.3 Path Analysis Between Standing Static Anthropometry and Forward Mid Position Arm Reach Height of Women

Path analysis between selected standing static anthropometry and forward mid position arm reach height is exemplified in Table 38 and Figure 28.

It is obvious from the Table that the total effect of normal standing height (0.50), mid-shoulder height (0.40), hand length (0.37), elbow height (0.45), waist height (0.52) and span (0.45) on forward mid position arm reach height of women was positive and significant.

The distribution of direct and indirect effect of normal standing height (0.38), mid-shoulder height (0.42), hand length (0.33), elbow height (0.29), and span (0.39) on forward mid position reach height of women expressed that these variables were having more indirect effect on forward mid position arm reach height of women in standing position than direct effect. While the direct (0.27) and indirect (0.25) effect of waist height on forward mid position arm reach height of women was approximately equal.

Table 38 Path Analysis Between Standing Static Anthropometry and Forward Mid Position Arm Reach Height (D_{19}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.50	0.12	0.38	0.21(S_{10})	0.11(S_8)
Mid Shoulder Height (S_4)	0.40	-0.02	0.42	0.17(S_{10})	0.10(S_8)
Hand Length (S_5)	0.37	0.04	0.33	0.15(S_{10})	0.08(S_8)
Elbow Height (S_8)	0.45	0.16	0.29	0.17(S_{10})	0.08(S_1)
Waist Height (S_{10})	0.52	0.27	0.25	0.10(S_8)	0.09(S_1)
Span (S_{14})	0.45	0.06	0.39	0.19(S_{10})	0.09(S_1)

Substantial indirect effect of selected static measurements on forward mid position arm reach height of women indicated that the static anthropometric measurements like normal standing height (0.21), mid-shoulder height (0.17), hand length (0.15), elbow height (0.17) and span (0.19) were having indirect effect on forward middle position reach height through waist height where as waist height (0.10) showed indirect effect on forward mid position arm reach height via elbow height of women.

It is summarized that waist height and elbow height were the static anthropometric measurements contributing to forward mid position arm reach height of women in standing position.

4.4.11 Relationship Between Standing Static Anthropometric Measurements and Forward Lower Position Arm Reach Height of Women

4.4.11.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Lower Position Arm Reach Height of Women

Simple Correlation and Regression Analysis between standing static anthropometry and forward lower position arm reach height of women is exemplified in Table 39 and Figure 29.

It is evident from the Table that the forward lower position arm reach height of women was positively correlated only with elbow height ($r=0.13^{**}$) of women Thus, indicated that the increase in forward lower position arm reach height of women was directly associated with increase in elbow height of women in standing position.

Table 39 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Lower Position Arm Reach Height (D_{20}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.08NS	0.006	D_{20}=10.75+0.04 S_1
Mid Shoulder Height (S_4)	0.06NS	0.003	D_{20}=14.16+0.028 S_4
Hand Length (S_5)	0.04NS	0.001	D_{20}=15.69+0.03 S_5
Elbow Height (S_8)	0.13^{**}	0.016	D_{20}=9.52+0.08 S_8
Waist Height (S_{10})	0.08NS	0.006	D_{20}=12.1+0.06 S_{10}
Span (S_{14})	0.05NS	0.002	D_{20}=14.3+0.02 S_{14}

** Significant at 1% level of significance NS Non significant

The value of 'r' square indicated meager effect of elbow height (1%) on forward lower position arm reach height of women. Regression coefficient indicated that one cm increase in elbow height increased forward lower position arm reach height of women by 0.08 centimeter.

4.4.11.2 The Multiple Regression Model of Forward Lower Position Arm Reach Height of Women With Standing Static Anthropometry

The multiple regression model of forward lower position arm reach height of women with standing static anthropometry is presented in Table 40

It is clear from the Table that the selected set of static anthropometry could explain the variation in forward lower position arm reach height by only 2 per cent. Elbow height ($t=2.28^{*}$) contributed significantly and positively to the forward lower position arm reach height with partial regression coefficient of 0.09. This explains that one-centimeter increase in elbow height having other variables constant can cause 0.09 cm increase in forward lower position arm reach height of women.

Table 40 The Multiple Regression Model of Forward Lower Position Arm Reach Height (D_{20}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.01	0.06	0.19NS
Mid Shoulder Height (S_4)	-0.02	0.04	-0.48NS
Hand Length (S_5)	-0.002	0.06	-0.04NS
Elbow Height (S_8)	0.09	0.04	2.28^{*}
Waist Height (S_{10})	0.02	0.05	0.47NS
Span (S_{14})	-0.02	0.04	-0.60NS

B_0= 10.72 R^2=0.02 F=1.61NS

* Significant at 5% level of significance NS Non significant

4.4.11.3 Partial Regression Analysis Between Standing Static Anthropometry and Forward Lower Position Arm Reach Height of Women

Path analysis between selected standing static anthropometry and forward lower position arm reach height of women is presented in Table 41 and Figure 30.

The total correlation of the selected static anthropometric measurements of women in standing position with forward lower position arm reach height was non significant except for elbow height (0.13) which was significant at 5 per cent level of significance. It is clear from the Table that the direct effect and indirect effect caused by static measurements of women on forward lower position arm reach height of women was meager in the range of –0.003 – 0.15.

Table 41 Path Analysis Between Standing Static Anthropometry and Forward Lower Position Arm Reach Height (D_{20}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.08	0.02	0.06	0.10(S_8)	-0.04(S_{14})
Mid Shoulder Height (S_4)	0.06	-0.04	0.10	0.09(S_8)	-0.03(S_{14})
Hand Length (S_5)	0.04	-0.003	0.043	0.07(S_8)	-0.03(S_{14})
Elbow Height (S_8)	0.13	0.15	-0.02	-0.03(S_{14})	-0.02(S_4)
Waist Height (S_{10})	0.08	0.04	0.04	0.09(S_8)	-0.04(S_{14})
Span (S_{14})	0.05	-0.05	0.10	0.08(S_8)	0.02(S_{10})

In general it can be inferred that the selected static measurements have less contribution in determination of forward lower position arm reach height of women in standing position.

4.4.12 Relationship Between Standing Static Anthropometric Measurements and Forward Upper Position Grasp Reach Height of Women

4.4.12.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Upper Position Grasp Reach Height of Women

Simple correlation and regression analysis between standing static anthropometry and forward upper position grasp reach height of women is presented in Table 42 and Figure 31.

It is evidenced from the Table that the forward upper position grasp reach height of women was positively correlated with normal standing height ($r=0.61^{**}$), mid-shoulder height ($r=0.48^{**}$), hand length ($r=0.50^{**}$), elbow height ($r=0.48^{**}$), waist height ($r=0.60^{**}$) and span ($r=0.62^{**}$) of women. Thus, indicated that the increase in forward upper position grasp reach height of women was directly associated with increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span of women in standing position.

The values of ‘r’ square indicated approximately equal percentage effect of normal standing height (0.37); waist height (0.36) and span (0.38) on forward upper position grasp reach height of women. The percentage range of 23-25 was observed for the effect of mid-shoulder height, elbow height and hand length on forward upper position grasp reach height of women.

Table 42 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Upper Position Grasp Reach Height (D_{24}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.61^{**}	0.37	D_{24}=37.10 + 0.88 S_1
Mid Shoulder Height (S_4)	0.48^{**}	0.23	D_{24}=92.57 + 0.59 S_4
Hand Length (S_5)	0.50^{**}	0.25	D_{24}=101.00 +1.0 S_5
Elbow Height (S_8)	0.48^{**}	0.23	D_{24}=93.68 + 0.78 S_8
Waist Height (S_{10})	0.60^{**}	0.36	D_{24}=66.78 +1.09 S_{10}
Span (S_{14})	0.62^{**}	0.38	D_{24}=54.12 +0.74 S_{14}

** Significant at 1% level of significance

Regression coefficient indicated that one cm increase in normal standing height, hand length and waist height increased forward upper position grasp reach height of women by 0.88cm, 1.00cm and 1.09 cm respectively. The increase of 0.59cm, 0.78cm and 0.74cm in forward upper position grasp reach height was noticed with an increase of 1 cm in mid-shoulder height, elbow height and span of women respectively.

4.4.12.2 The Multiple Regression Model of Forward Upper Position Grasp Reach Height of Women With Standing Static Anthropometry

The multiple regression model of forward upper position grasp reach height of women with standing static anthropometry is presented in Table 43.

It is clear from the Table that the selected set of static anthropometry could explain the variation in forward upper position grasp reach height by 45 per cent. Hand length ($t=2.12^{*}$), waist height ($t=4.25^{**}$) and span ($t=4.23^{**}$) contributed significantly and positively to the forward upper position grasp reach height with partial regression coefficient of 0.23, 0.43 and0.31 respectively.

Table 43 The Multiple Regression Model of Forward Upper Position Grasp Reach Height (D_{24}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.17	0.11	1.56NS
Mid Shoulder Height (S_4)	-0.06	0.07	-0.87NS
Hand Length (S_5)	0.23	0.11	2.12^{*}
Elbow Height (S_8)	0.13	0.07	1.74NS
Waist Height (S_{10})	0.43	0.10	4.25^{**}
Span (S_{14})	0.31	0.07	4.23^{**}

B_0= 32.49 R^2=0.45 F=68.07^{**}

** Significant at 1% level of significance * Significant at 5% level of significance

NS Non significant

Multiple regression explained that one centimeter increase in hand length having other variables constant can cause 0.23 cm increase in forward upper position grasp reach height whereas, 0.43 cm increase in forward upper position grasp reach height was explained with an increase of 1 cm in waist height keeping all other measurements at constant. The increase of 0.31cm in forward upper position grasp reach height was explained with an increase of 1 cm in span of women.

4.4.12.3 Path Analysis Between Standing Static Anthropometry and Forward Upper Position Grasp Reach Height of Women

Path analysis between selected standing static anthropometry and forward upper position grasp reach height is presented in Table 44 and Figure 32.

It is clear from the Table that the total effect of normal standing height (0.61), mid-shoulder height (0.48), hand length (0.50), elbow height (0.48), waist height (0.60) and span (0.62) on forward upper position grasp reach height was positive and significant but showed more indirect effect with respective values of 0.49, 0.53, 0.39, 0.40, 0.46 and 0.36.

Table 44 Path Analysis Between Standing Static Anthropometry and Forward Upper Position Grasp Reach Height (D_{24}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.61	0.12	0.49	0.21(S_{14})	0.19(S_{10})
Mid Shoulder Height (S_4)	0.48	-0.05	0.53	0.16(S_{14})	0.15(S_{10})
Hand Length (S_5)	0.50	0.11	0.39	0.18(S_{14})	0.13(S_{10})
Elbow Height (S_8)	0.48	0.08	0.40	0.15(S_{10})	0.15(S_{14})
Waist Height (S_{10})	0.60	0.24	0.46	0.19(S_{14})	0.09(S_1)
Span (S_{14})	0.62	0.26	0.36	0.17(S_{10})	0.10(S_1)

Substantial indirect effect of normal standing height (0.21), mid-shoulder height (0.16), hand length (0.18) and waist height (0.19) on forward upper position grasp reach height of women was positive through span of women while the effect of elbow height (0.15) and span (0.17) on forward upper position grasp reach height of women was positive through waist height of women in standing position.

Thus, it can be inferred from the Table that span and waist height contributes more in determination of forward upper position grasp reach height of women.

4.4.13 Relationship Between Standing Static Anthropometric Measurements and Forward Mid Position Grasp Reach Height of Women

4.4.13.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Mid Position Grasp Reach Height of women

Simple correlation and regression analysis between standing static anthropometry and forward mid position grasp reach height of women is presented in Table 45 and in Figure 33.

It is evident from the Table that the forward mid position grasp reach height of women was positively correlated with normal standing height ($r=0.50^{**}$), mid-shoulder height ($r=0.39^{**}$), Hand length ($r=0.37^{**}$), elbow height ($r=0.45^{**}$), waist height ($r=0.50^{**}$) and span ($r=0.44^{**}$) of women, indicating an increase in forward mid position grasp reach height of women was directly associated with normal standing height, mid-shoulder height, hand length, elbow height, waist height and span of women in standing position. The values of 'r' square indicated 25 per cent effect of normal standing height and waist height on forward mid position grasp reach height. Approximately similar per cent effect of span (19 %) and elbow height (20%) was noticed on forward mid position grasp reach height of women. The percentage effect of mid-shoulder height and hand length on forward mid position grasp reach height of women was noted as 15 and 13 respectively.

Table 45 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Mid Position Grasp Reach Height (D_{25}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Normal Standing Height (S_1)	0.50^{**}	0.25	$D_{25}=48.24+0.51\ S_1$
Mid Shoulder Height (S_4)	0.39^{**}	0.15	$D_{25}=81.12+0.34\ S_4$
Hand Length (S_5)	0.37^{**}	0.13	$D_{25}=89.95+0.53\ S_5$
Elbow Height (S_8)	0.45^{**}	0.20	$D_{25}=75.41+0.52\ S_8$
Waist Height (S_{10})	0.50^{**}	0.25	$D_{25}=65.65+0.64\ S_{10}$
Span (S_{14})	0.44^{**}	0.19	$D_{25}=67.15+0.38\ S_{14}$

** Significant at 1% level of significance

Regression coefficient indicated that one centimeter increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span increased forward mid position grasp reach height of women by 0.51cm, 0.34 cm, 0.53 cm, 0.52 cm, 0.64 cm and 0.38 cm respectively.

4.4.13.2 The Multiple Regression Model of Forward Mid Position Grasp Reach Height of Women With Standing Static Anthropometry

The multiple regression model of forward mid position grasp reach height of women with standing static anthropometry is presented in Table 46.

It is clear from the Table that the selected set of static anthropometry could explain the variation in forward mid position grasp reach height by 30 per cent. Normal standing height ($t=2.01^{*}$), elbow height ($t=3.20^{**}$) and waist height ($t=3.37^{**}$) contributed significantly and positively to the forward mid position grasp reach height with partial regression coefficient of 0.17, 0.20 and 0.28 respectively.

Table 46 The Multiple Regression Model of Forward Mid Position Grasp Reach Height (D_{25}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.17	0.09	2.01*
Mid Shoulder Height (S_4)	-0.04	0.06	-0.74NS
Hand Length (S_5)	0.10	0.09	1.19NS
Elbow Height (S_8)	0.20	0.06	3.20^{**}
Waist Height (S_{10})	0.28	0.08	3.37^{**}
Span (S_{14})	0.03	0.06	0.60NS

B_0= 46.79 R^2=0.30 $F=35.10^{**}$

** Significant at 1% level of significance NS Non significant

This explains that one centimeter increase in normal standing height by keeping all other static measurements at constant can cause 0.17 cm increase in mid position grasp reach height of women. One-centimeter increase in elbow height and waist height can cause an increase of 0.20 and 0.28 centimeter in forward mid position grasp reach height of women.

4.4.13.3 Path Analysis Between Standing Static Anthropometry and Forward Mid Position Grasp Reach Height of Women

Path analysis between selected standing static anthropometry and forward mid position grasp reach height of women is depicted in Table 47 and Figure 34.

It is obvious from the Table that the total effect of normal standing height (0.50), mid-shoulder height (0.39), hand length (0.37), elbow height (0.45), waist height (0.50) and span (0.44) on forward mid position grasp reach height of women was positive and significant. The indirect effect of normal standing height (0.33), mid-shoulder height (0.44), hand length (0.30), elbow height (0.28), waist height (0.28) and span (0.40) on forward mid position grasp reach height of women was more and positive than the direct effect.

Table 47 Path Analysis Between Standing Static Anthropometry and Forward Mid Position Grasp Reach Height (D_{25}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.50	0.17	0.33	0.07(S_{10})	0.12(S_8)
Mid Shoulder Height (S_4)	0.39	-0.05	0.44	0.13(S_{10})	0.12(S_1)
Hand Length (S_5)	0.37	0.07	0.30	0.12(S_{10})	0.10(S_1)
Elbow Height (S_8)	0.45	0.17	0.28	0.14(S_{10})	0.12(S_1)
Waist Height (S_{10})	0.50	0.22	0.28	0.13(S_1)	0.11(S_8)
Span (S_{14})	0.44	0.04	0.40	0.15(S_{10})	0.14(S_1)

Substantial effect of normal standing height via elbow height (0.12) was more than via waist height (0.07). Substantial effect of mid-shoulder height (0.13), hand length (0.12), elbow height (0.14) and span (0.15) via waist height was more followed by normal standing height. Effect of waist height on forward mid position grasp reach height of women via normal standing height was 0.13 and via elbow height was 0.11.

Thus, it can be said that normal standing height, waist height and elbow height contributes to the forward mid position grasp reach height of women in standing position.

4.4.14 Relationship Between Standing Static Anthropometry and Forward Lower Position Grasp Reach Height of Women

4.4.14.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Lower Position Grasp Reach Height of Women

Simple correlation and regression analysis between standing static anthropometry and forward lower position grasp reach height of women is depicted in Table 48 and Figure 35.

It is evident from the Table that the forward lower position grasp reach height of women was positively correlated only with waist height ($r=0.10^{*}$) of women which indicates that the increase in forward lower position grasp reach height of women was directly associated with increase in waist height of women in standing position.

Table 48 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Lower Position Grasp Reach Height (D_{26}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.01NS	0.0001	D_{26}=25.07+0.008 S_1
Mid Shoulder Height (S_4)	0.03NS	0.0009	D_{26}=24.20+0.016 S_4
Hand Length (S_5)	0.02NS	0.02	D_{26}=25.35+0.01 S_5
Elbow Height (S_8)	0.09NS	0.008	D_{26}=20.37+0.06 S_8
Waist Height (S_{10})	0.10*	0.01	D_{26}=18.89+0.07 S_{10}
Span (S_{14})	0.03NS	0.0009	D_{26}=24.06+0.01 S_{14}

* Significant at 5% level NS Non significant

The value of 'r' square indicated meager effect of waist height (1%) on forward lower position grasp reach height of women. Regression coefficient indicated that one cm increase in waist height increased forward lower position grasp reach height of women by 0.07 centimeter.

4.4.14.2 The Multiple Regression Model of Forward Lower Position Grasp Reach Height of Women With Standing Static Anthropometry

The multiple regression model of forward lower position grasp reach height of women with standing static anthropometry is presented in Table 49.

It is clear from the Table that the selected set of static anthropometry could explain the variation in forward lower position grasp reach height by only 3 per cent. Waist height (t=2.85**) contributed significantly and positively to the forward lower position grasp reach height with partial regression coefficient of 0.16.

Table 49 The Multiple Regression Model of Forward Lower Position Grasp Reach Height (D_{26}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	-0.15	0.06	-2.46*
Mid Shoulder Height (S_4)	0.007	0.04	0.19NS
Hand Length (S_5)	-0.04	0.06	-0.64NS
Elbow Height (S_8)	0.08	0.04	1.87NS
Waist Height (S_{10})	0.16	0.06	2.85**
Span (S_{14})	0.01	0.04	0.36NS

B_0=24.79 R^2=0.03 F=2.49*

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

Values of partial regression coefficient explains that one-centimeter increase in waist height having other variables constant can cause 0.16 cm increase in forward lower position grasp reach height of women. Normal standing height of women exhibited negative contribution to forward lower position grasp reach height (t=-2.46*) explaining 0.15 cm decrease with an increase of 1 cm in normal standing height (bi=-0.15).

4.4.14.3 Path Analysis Between Standing Static Anthropometry and Forward Lower Position Grasp Reach Height of Women

Path analysis between selected standing static anthropometry and forward lower position grasp reach height of women is depicted in Table 50 and presented in Figure 36.

It is apparent from the Table that only waist height of women had total positive and significant effect on forward lower position grasp reach height of women in standing position.

Table 50 Path Analysis Between Standing Static Anthropometry and Forward Lower Position Grasp Reach Height (D_{26}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.01	-0.25	0.26	0.17(S_{10})	0.08(S_8)
Mid Shoulder Height (S_4)	0.03	0.01	0.02	-0.18(S_1)	0.13(S_{10})
Hand Length (S_5)	0.01	-0.05	0.07	-0.15(S_1)	0.12(S_{10})
Elbow Height (S_8)	0.09	0.12	-0.03	-0.17(S_1)	0.1(S_{10})
Waist Height (S_{10})	0.10	0.21	-0.11	-0.19(S_1)	0.08(S_8)
Span (S_{14})	0.03	0.03	0.00	-0.20(S_1)	0.15(S_{10})

Direct effect of normal standing height (-0.25) on forward lower position grasp reach height of women was negative and waist height (0.21) and elbow height (0.12) was positive. Effect of normal standing height (0.26) on forward lower position grasp reach height of women was positive. Substantial positive indirect effect of normal standing height was recorded through waist height on forward lower position grasp reach height of women while the effect of mid-shoulder height (-0.18), hand length (-0.15), elbow height (-0.17), waist height (-0.19) and span (-0.20) on forward lower position grasp reach height of women was negative via normal standing height.

It can be summarized that normal standing height and waist height contributed more to forward lower position grasp reach height of women in standing position.

4.5 Relationship Between Standing Static And Horizontal Dynamic Anthropometry of Women

4.5.1 Relationship Between Standing Static Anthropometric Measurements and Upper Position Arm Reach Length of women

4.5.1.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Upper position Arm Reach length of Women

Simple correlation and regression analysis between standing static anthropometry and upper position arm reach length of women is presented in Table 51 and illustrated in Figure 37

It is clear from the Table that all selected static anthropometric measurements like normal standing height ($r=0.35^{**}$), mid-shoulder height ($r=0.26^{**}$), hand length ($r=0.44^{**}$), elbow height ($r=0.20^{**}$), waist height ($r=0.25^{**}$) and span ($r=0.39^{**}$) were positively correlated with upper position arm reach length of women in standing position. Thus, indicating that the upper position arm reach length of women was found to be increased with an increase in selected set of static anthropometric measurements of women.

Table 51 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Upper Position Arm Reach Length (D_3) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}= a+bx$)
Normal Standing Height (S_1)	0.35^{**}	0.12	$D_3=17.09+0.38S_1$
Mid Shoulder Height (S_4)	0.26^{**}	0.07	$D_3=43.24+0.24S_4$
Hand Length (S_5)	0.44^{**}	0.19	$D_3=28.99+0.67S_5$
Elbow Height (S_8)	0.20^{**}	0.04	$D_3=51.24+0.24S_8$
Waist Height (S_{10})	0.25^{**}	0.06	$D_3=43.49+0.33S_{10}$
Span (S_{14})	0.39^{**}	0.15	$D_3=19.73+0.35S_{14}$

** Significant at 1% level of significance

Regression coefficient indicated maximum increase of 0.67 cm in upper position arm reach length with the increase of 1 cm in hand length. One centimeter increase in normal standing height (0.38), waist height (0.33) and span (0.35) increased the upper position length in the range of 0.33 to 0.38 cm Increase of 0.24 cm was noticed in upper position arm reach length of women with an increase of 1 cm in mid-shoulder and elbow height. Per cent effect of selected static measurements as indicated by values of 'r' square was in the range of 4 to 19.

4.5.1.2 The Multiple Regression Model of Upper Position Arm Reach Length of Women With Standing Static Anthropometry

The multiple regression model of upper position arm reach length of women with standing static anthropometry is reported in Table 52

It is evident from the Table that set of static anthropometric measurements included in regression analysis could explain the variation in upper position arm reach length to the extent of 25 per cent (R^2=0.25). Normal standing height (t=3.83**) and hand length (t=7.33**) contributed significantly and positively to the upper position length of women whereas, waist height (t=-2.5*) and mid-shoulder height (t=-3.47**) contributed significantly and negatively to the upper position arm reach length of women.

Partial regression coefficient indicated 0.36 cm and 0.69 cm increase in upper position arm reach length with an increase of 1 cm each in normal standing height and hand length. While the reduction of 0.22 cm was noticed with an increase of 1 cm in mid-shoulder height and waist height.

Table 52 The Multiple Regression Model of Upper Position Arm Reach Length (D_3) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.36	0.096	3.83**
Mid Shoulder Height (S_4)	-0.22	0.063	-3.47**
Hand Length (S_5)	0.69	0.094	7.33**
Elbow Height (S_8)	-0.07	0.067	-1.15NS
Waist Height (S_{10})	-0.22	0.09	-2.50*
Span (S_{14})	0.10	0.06	1.56NS

B_0= 13.70 R^2=0.25 F=27.81**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.5.1.3 Path Analysis Between Standing Static Anthropometry and Upper Position Arm Reach Length of Women

Path analysis between selected standing static anthropometry and upper position arm reach length of women is presented in Table 53 and illustrated in Figure 38.

It is clear from the Table that the highest total positive influence on upper position arm reach length of women was exerted by hand length (0.44), span (0.39) and normal standing height (0.35). The total effect of mid-shoulder height (0.26), elbow height (0.20) and waist height (0.25) was positive and in the range of 0.20-0.25

The direct effect of normal standing height (0.34) and hand length (0.46) on upper position arm reach length was positive and substantial whereas, the indirect effect of mid-shoulder height (0.50), elbow height (0.26), waist height (0.41) and span (0.28) was positive and substantial on upper position arm reach length of women in standing position. The indirect effect of normal standing height

(0.27), mid-shoulder height (0.33) and span (0.31) on upper position arm reach length was positive and substantial via hand length whereas, the indirect effect of hand length (0.20), elbow height (0.23) and waist height (0.26) was positive via normal standing height.

Table 53 Path Analysis Between Standing Static Anthropometry and Upper Position Arm Reach Length (D_3) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.35	0.34	0.01	0.27(S_5)	-0.17(S_4)
Mid Shoulder Height (S_4)	0.26	-0.24	0.50	0.33(S_5)	0.24(S_1)
Hand Length (S_5)	0.44	0.46	-0.02	0.20(S_1)	-0.17(S_4)
Elbow Height (S_8)	0.20	-0.06	0.26	0.23(S_1)	0.22(S_5)
Waist Height (S_{10})	0.25	-0.16	0.41	0.26(S_1)	0.26(S_5)
Span (S_{14})	0.39	0.11	0.28	0.31(S_5)	0.27(S_1)

It is Thus, concluded that normal standing height and hand length were important static measurements contributing to upper position arm reach length of women in standing position.

4.5.2 Relationship between standing static anthropometric measurements and Mid Position Arm Reach Length of women

4.5.2.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Mid Position Arm Reach Length of Women

Simple correlation and regression analysis between standing static anthropometry and mid position arm reach length with selected static anthropometry is presented in Table 54 and Figure 39.

The findings from the Table indicated that the selected static measurements were positively correlated with mid position arm reach length of women in standing position. One cm increase in normal standing height ($r=0.47^{**}$), mid-shoulder height ($r=0.35^{**}$), hand length ($r=0.52^{**}$), elbow height ($r=0.33^{**}$), waist height ($r=0.39^{**}$) and span ($r=0.49^{**}$) increased the mid position arm reach length of women by 0.46, 0.30, 0.72, 0.36, 0.48, and 0.39 cm respectively.

The values of 'r' square indicated 27 per cent and 24 per cent effect of hand length and span on mid position arm reach length of women in standing position respectively.

Table 54 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Mid Position Arm Reach Length (D_4) of women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Normal Standing Height (S_1)	0.47^{**}	0.22	D_4=12.67+0.46S_1
Mid Shoulder Height (S_4)	0.35^{**}	0.12	D_4=43.98+0.30S_4
Hand Length (S_5)	0.52^{**}	0.27	D_4=33.24+0.72S_5
Elbow Height S_8)	0.33^{**}	0.11	D_4=47.06+0.36S_8
Waist Height (S_{10})	0.39^{**}	0.15	D_4=37.43x+0.48S_{10}
Span (S_{14})	0.49^{**}	0.24	D_4=20.72+0.39S_{14}

** Significant at 1 per cent level of significance

4.5.2.2 The Multiple Regression Model of Mid Position Arm Reach Length of Women With Standing Static Anthropometry

The multiple regression model of mid position arm reach length of women with standing static anthropometry is reported in Table 55.

It is obvious from the Table that selected static anthropometric measurements could explain the variation in mid position arm reach length to the extent of 34 per cent (R^2=0.34). Normal standing height (t=4.08**) and hand length (t=8.08**) contributed positively and significantly and showed that 1 cm increase in normal standing height and hand length contributed to the increase of 0.33cm and 0.65cm in mid position arm reach length of women. A significant negative contribution was recorded for mid-shoulder height (t=-4.14**) with partial regression coefficient of –0.22, which indicated that 1 cm increase in mid-shoulder height, reduced mid position length of women by 0.22 cm

Table 55 The Multiple Regression Model of Mid Position Arm Reach Length (D_4) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.33	0.08	4.08**
Mid Shoulder Height (S_4)	-0.22	0.05	-4.14**
Hand Length (S_5)	0.65	0.08	8.08**
Elbow Height (S_8)	0.02	0.06	0.36NS
Waist Height (S_{10})	-0.05	0.07	-0.65NS
Span (S_{14})	0.06	0.05	1.16NS

B_0= 9.50 R^2=0.34 F=42.99**

** Significant at 1% level of significance NS Non significant

4.5.2.3 Path Analysis Between Standing Static Anthropometry and Mid Position Arm Reach Length of Women

Path analysis between selected squatting static anthropometry and mid position arm reach length of women is presented in Table 56 and presented in Figure 40.

The total effect of all selected static anthropometric measurements of women on mid position arm reach length was significant and positive. The total effect of hand length (0.52) on mid position arm reach length of women was more followed by span (0.49) and normal standing height (0.47). The total effect of mid-shoulder height (0.35), elbow height (0.33) and waist height (0.39) was in the range of 0.33-0.39.

Table 56 Path Analysis Between Standing Static Anthropometry and Mid position Arm Reach Length (D_4) of Women

Anthropometric Variables	**Total Effect**	**Direct Effect**	**Indirect Effect**	**Substantial Indirect Effect (I)**	**Substantial Indirect Effect (II)**
Normal Standing Height (S_1)	0.47	0.34	0.13	0.28(S_5)	-0.19(S_4)
Mid Shoulder Height (S_4)	0.35	-0.26	0.61	0.34(S_5)	0.24(S_1)
Hand Length (S_5)	0.52	0.47	0.05	0.2(S_1)	-0.19(S_4)
Elbow Height (S_8)	0.33	0.02	0.31	0.23 (S_1)	0.23(S_5)
Waist Height (S_{10})	0.39	-0.04	0.43	0.26 (S_1)	0.26 (S_5)
Span (S_{14})	0.49	0.08	0.41	0.32(S_5)	0.27(S_1)

The effect of normal standing height (0.34) and hand length (0.47) on mid position arm reach length of women was direct, positive and substantial whereas, the variables like mid-shoulder height (0.61), elbow height (0.31), waist height (0.43) and span (0.41) were found to have indirect, positive and substantial effect on mid position arm reach length of women in standing position.

Substantial indirect effect of normal standing height (0.28), mid-shoulder height (0.34) and span (0.32) on middle position length of women was positive via hand length while the effect of hand length (0.2), elbow height (0.23) and waist height (0.26) was substantially positive via normal standing height.

Subsequent indirect effect of normal standing height (-0.19) and hand length (-0.19) on mid position arm reach length was negative via mid-shoulder height.

Thus, it is concluded that normal standing height and hand length were contributing positively in determination of mid position arm reach length and mid-shoulder height contributed negatively to mid position length of women in standing position.

4.5.3 Relationship Between Standing Static Anthropometric Measurements and Lower Position Arm Reach Length of Women

4.5.3.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Lower Position Arm Reach Length of Women

Simple correlation and regression analysis between standing static anthropometry and lower position arm reach length of women is presented in Table 57 and Figure 41.

As seen from the Table the lower position arm reach length was positively correlated with normal standing height ($r=0.35^{**}$), mid-shoulder height ($r=0.27^{**}$), hand length ($r=0.44^{**}$), elbow height ($r=0.20^{**}$), waist height($r=0.24^{**}$) and span ($r=0.39^{**}$) of women in standing position. These values indicated that the lower position arm reach length increases with an increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height, and span of women. The per cent impact of hand length, span and normal standing height on lower position arm reach length was 19, 15 and 12 respectively.

Regression coefficient indicated that one centimeter increase each in static measurements like normal standing height, mid-shoulder height, hand length, elbow height, waist height and span effected in increase of lower position arm reach length by 0.37,0.25,0.66,0.23,0.32 and 0.34 cm respectively.

Table 57 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Lower Position Arm Reach Length (D_5) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Normal Standing Height (S_1)	0.35^{**}	0.12	D_5=16.17+0.37S_1
Mid Shoulder Height (S_4)	0.27^{**}	0.07	D_5=39.97+0.25S_4
Hand Length (S_5)	0.44^{**}	0.19	D_5=26.92+0.66S_5
Elbow Height (S_8)	0.20^{**}	0.04	D_5=49.63+0.23S_8
Waist Height (S_{10})	0.24^{**}	0.06	D_5=42.25+0.32S_{10}
Span (S_{14})	0.39^{**}	0.15	D_5=18.42+0.34S_{14}

** Significant at 1% level of significance

4.5.3.2 The Multiple Regression Model of Lower Position Arm Reach Length of Women With Standing Static Anthropometry

The multiple regression model of lower position arm reach length of women with standing static anthropometry is presented in Table 58.

It is clear from the Table that the selected set of static anthropometry could explain the variation in lower position arm reach length by 24 per cent. Normal standing height ($t=3.52^{**}$) and hand length ($t=7.07^{**}$) contributed significantly and positively to the lower position arm reach length with partial regression coefficient of 0.33 and0.67. This explains that one centimeter increase in normal standing height having other variables constant can cause 0.33 cm increase in lower position arm reach length whereas, 0.67 cm increase in lower position arm reach length was explained with an increase of 1 cm in hand length keeping all other measurements at constant. Mid-shoulder height (t=-2.86**) and waist height (t=-2.57**) exerted negative effect on lower position arm reach length of women with partial regression coefficient values of –0.18 and -0.23 indicating that the lower position length reduced by 0.18 and 0.23 cm with an increase of one cm each in mid-shoulder height and waist height respectively.

Table 58 The Multiple Regression Model of Lower Position Arm Reach Length (D_5) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.33	0.1	3.52**
Mid Shoulder Height (S_4)	-0.18	0.06	-2.86**
Hand Length (S_5)	0.67	0.09	7.07**
Elbow Height (S_8)	-0.08	0.07	-1.23NS
Waist Height (S_{10})	-0.23	0.09	-2.57**
Span (S_{14})	0.10	0.06	1.60NS

B_0= 12.72 R^2= 0.24 F= 26.38**

** Significant at 1% level of significance NS Non significant

4.5.3.3 Path Analysis Between Standing Static Anthropometry and Lower Position Arm Reach Length of Women

Path analysis between selected standing static anthropometry and lower position arm reach length is presented in Table 59 and Figure 42.

Total effect of selected static anthropometry on lower position arm reach length of women was significant and positive. Total effect of hand length (0.44), span (0.39) and normal standing height (0.35) was more on lower position length of women. The variables like normal standing height (0.31) and hand length (0.45) were having direct, substantial and positive effect on lower position length of women in standing position whereas, the effect of mid-shoulder height (0.47), elbow height (0.27) waist height (0.41) and span (0.27) recorded indirect effect on lower position arm reach length of women in standing position.

Table 59 Path Analysis Between Standing Static Anthropometry and Lower Position Arm Reach Length (D_5) of women

Anthropometric Variables	**Total Effect**	**Direct Effect**	**Indirect Effect**	**Substantial Indirect Effect (I)**	**Substantial Indirect Effect (II)**
Normal Standing Height (S_1)	0.35	0.31	0.04	0.27(S_5)	-0.14(S_4)
Mid Shoulder Height (S_4)	0.27	-0.20	0.47	0.32(S_5)	0.23(S_1)
Hand Length (S_5)	0.44	0.45	-0.01	0.19(S_1)	-0.14(S_4)
Elbow Height (S_8)	0.20	-0.07	0.27	0.22(S_1)	0.21(S_5)
Waist Height (S_{10})	0.24	-0.17	0.41	0.25(S_5)	0.24 (S_1)
Span (S_{14})	0.39	0.12	0.27	0.30(S_5)	0.25(S_1)

Substantial indirect effect of normal standing height (0.27), mid-shoulder height (0.32), waist height (0.25) and span (0.30) on lower position arm reach length of women was noticed via hand length. Substantial indirect effect of hand length and elbow height on lower position arm reach length of women was noticed via normal standing height. Equal and negative indirect effect of normal standing height (-014) and hand length (-0.14) on lower position length of women was recorded via mid-shoulder height.

Above findings indicated that normal standing height and hand length of women affects the lower position arm reach length of women in standing position.

4.5.4 Relationship Between Standing Static Anthropometric Measurements and Upper Position Grasp Reach Length of women

4.5.4.1 Simple Correlation and Regression Analysis Between Static Anthropometry and Upper Position Grasp Reach Length of Women

Simple correlation and regression analysis between standing static anthropometry and upper position grasp reach length is presented in Table 60 and Figure 43.

It is clear from the Table that all selected static anthropometric measurements like normal standing height ($r=0.32^{**}$), mid-shoulder height ($r=0.24^{**}$), hand length ($r=0.41^{**}$), elbow height ($r=0.19^{**}$), waist height ($r=0.23^{**}$) and span ($r=0.36^{**}$) were positively correlated with upper position grasp reach length of women in standing position. This indicated that the upper position grasp reach length of women was found to be increased with an increase in selected set of static anthropometric measurements of women.

Table 60 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Upper Position Grasp Reach Length (D_{12}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Normal Standing Height (S_1)	0.32^{**}	0.10	$D_{12}=14.35+0.35\ S_1$
Mid Shoulder Height (S_4)	0.24^{**}	0.06	$D_{12}=37.64+0.22\ S_4$
Hand Length (S_5)	0.41^{**}	0.17	$D_{12}=24.43+0.62\ S_5$
Elbow Height (S_8)	0.19^{**}	0.03	$D_{12}=44.70+0.23\ S_8$
Waist Height (S_{10})	0.23^{**}	0.05	$D_{12}=37.88+0.31\ S_{10}$
Span (S_{14})	0.36^{**}	0.13	$D_{12}=16.27+0.32\ S_{14}$

** Significant at 1% level of significance

Values of ‘r’ square indicated 17 Per cent effect of hand length on upper position grasp reach length of women followed by 13 per cent effect of span of women and 10 per cent effect of normal standing height of women. Other static measurements such as mid-shoulder height, elbow height and waist height showed very meager effect of 3 to 6 per cent on upper position grasp reach length of women.

Regression coefficient indicated maximum increase of 0.62 cm in upper position grasp reach length with the increase of 1 cm in hand length. One centimeter increase in normal standing height (0.35), waist height (0.31) and span (0.32) increased the upper position grasp length in the range of 0.31 to 0.35cm Increase of 0.22 and 0.23 cm was noticed in upper position grasp reach length of women with an increase of 1 cm in mid-shoulder height and elbow height respectively.

4.5.4.2 The Multiple Regression Model of Upper Position Grasp Reach Length of Women With Standing Static Anthropometry

The multiple regression model of upper position grasp reach length of women with standing static anthropometry is reported in Table 61

It is evident from the Table that set of static anthropometric measurements included in regression analysis could explain the variation in upper position grasp reach length to the extent of 21 per cent (R^2=0.21). Normal standing height (t=3.16**) and hand length (t=6.60**) contributed significantly and positively to the upper position grasp reach length of women whereas, mid-shoulder height (t=-3.04**) and waist height (t=-2.12*) contributed significantly and negatively to the upper position grasp reach length of women.

Partial regression coefficient revealed an increase of 0.31 cm and 0.64 cm in upper position grasp reach length with an increase of 1 cm each in normal standing height and hand length while the reduction of 0.19 and 0.2 cm was noticed with an increase of 1 cm each in mid-shoulder height and waist height.

Table 61 The Multiple Regression Model of Upper Position Grasp Reach Length (D_{12}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal standing height (S_1)	0.31	0.10	3.16**
Mid Shoulder Height (S_4)	-0.19	0.06	-3.04**
Hand Length (S_5)	0.64	0.10	6.60**
Elbow Height (S_8)	-0.06	0.07	-0.83NS
Waist Height (S_{10})	-0.20	0.09	-2.12*
Span (S_{14})	0.09	0.06	1.44NS

B_0= 11.11 R^2=0.21 F=22.09**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non-significant

4.5.4.3 Path Analysis Between Standing Static Anthropometry and Upper Position Grasp Reach Length of Women

Path analysis between selected standing static anthropometry and upper position grasp reach length of women is presented in Table 62 and Figure 44.

It is clear from the Table that the highest total positive influence on upper position grasp reach length of women was exerted by hand length (0.41), span (0.36) and normal standing height (0.32). The total effect of mid-shoulder height (0.24), elbow height (0.19) and waist height (0.23) was positive and in the range of 0.19-0.24.

The direct effect of normal standing height (0.29) and hand length (0.43) on upper position grasp reach length was positive and substantial whereas, the indirect effect of mid-shoulder height (0.45), elbow height (0.24), waist height (0.37) and span (0.25) was positive and substantial on upper position grasp reach length of women in standing position. The indirect effect of normal standing height (0.25), mid-shoulder height (0.31), elbow height (0.20), waist height (0.24) and span (0.29) on upper position grasp reach length was positive and substantial via hand length whereas, the indirect effect of hand length (0.17) was positive via normal standing height.

Table 62 Path Analysis Between Standing Static Anthropometry and Upper Position Grasp Reach Length (D_{12}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.32	0.29	0.03	0.25(S_5)	-0.15(S_4)
Mid Shoulder Height (S_4)	0.24	-0.21	0.45	0.31(S_5)	0.21(S_1)
Hand Length (S_5)	0.41	0.43	-0.02	0.17(S_1)	-0.15(S_4)
Elbow Height (S_8)	0.19	-0.05	0.24	0.20(S_5)	0.19 (S_1)
Waist Height (S_{10})	0.23	-0.14	0.37	0.24(S_5)	0.22(S_1)
Span (S_{14})	0.36	0.11	0.25	0.29(S_5)	0.23(S_1)

It can be concluded from the above analysis that normal standing height and hand length were important static measurements contributing to upper position grasp reach length of women in standing position.

4.5.5 Relationship Between Standing Static Anthropometric Measurements and Mid Position Grasp Reach Length of Women

4.5.5.1 Simple Correlation and Regression Analysis between Standing Static Anthropometry and Mid Position Grasp Reach Length of Women

Simple correlation and regression analysis between standing static anthropometry and mid position grasp reach length of women is reported in Table 63 and explained in Figure 45.

The findings from the Table indicates that the selected static measurements like Normal standing height ($r=0.43^{**}$), mid-shoulder height ($r=0.32^{**}$), hand length ($r=0.49^{**}$), elbow height ($r=0.32^{**}$), waist height ($r=0.36^{**}$) and span ($r=0.45^{**}$) are positively correlated with mid position grasp reach length of women in standing position.

Table 63 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Mid Position Grasp Reach Length (D_{13}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Normal standing height (S_1)	0.43^{**}	0.18	$D_{13}=11.61+0.42\ S_1$
Mid Shoulder Height (S_4)	0.32^{**}	0.10	$D_{13}=39.78+0.27\ S_4$
Hand Length (S_5)	0.49^{**}	0.24	$D_{13}=29.23+0.67\ S_5$
Elbow Height (S_8)	0.32^{**}	0.10	$D_{13}=41.4+0.34\ S_8$
Waist Height (S_{10})	0.36^{**}	0.13	$D_{13}=33.60+0.44\ S_{10}$
Span (S_{14})	0.45^{**}	0.20	$D_{13}=18.25+0.36\ S_{14}$

** Significant at 1% level of significance

The values of ‘r’ square indicated 24 per cent effect of hand length, 20 per cent effect of span and 18 per cent effect of normal standing height on mid position grasp reach length of women in standing position. Statistical values of regression coefficient exhibited that one cm increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height and span increased the mid position grasp reach length of women by 0.42, 0.27, 0.67, 0.34, 0.44, and 0.36 cm respectively.

4.5.5.2 The Multiple Regression Model of Mid Position Grasp Reach Length of Women With Standing Static Anthropometry

The multiple regression model of mid position grasp reach length of women with standing static anthropometry is noted in Table 64.

It is clear from the Table that selected static anthropometric measurements could explain the variation in mid position grasp reach length to the extent of 29 per cent (R^2=0.29).

Table 64 The Multiple Regression Model of Mid Position Grasp Reach Length (D_{13}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.28	0.08	3.33^{**}
Mid Shoulder Height (S_4)	-0.21	0.05	-3.86^{**}
Hand Length (S_5)	0.61	0.08	7.41^{**}
Elbow Height (S_8)	0.04	0.06	0.76NS
Waist Height (S_{10})	-0.04	0.08	-0.56NS
Span (S_{14})	0.06	0.06	1.10NS

B_0=8.52 R^2=0.29 F=34.42^{**}

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

Normal standing height (t=3.33^{**}) and hand length (t=7.41^{**}) contributed positively and significantly and showed that 1 cm increase in normal standing height and hand length contributed to an increase of 0.28cm and 0.61cm in mid position grasp reach length of women. A significant negative contribution was recorded for mid-shoulder height (t=-3.86**) with partial regression coefficient of –0.21, which indicated that 1 cm increase in mid-shoulder height reduced mid position grasp length of women, by 0.21 cm.

4.5.5.3 Path Analysis Between Standing Static Anthropometry and Mid Position Grasp Reach Length of Women.

Path analysis between selected standing static anthropometry and mid position grasp reach length of women in standing position is presented in Table 65 and Figure 46.

The total effect of all selected static anthropometric measurements of women on mid position grasp reach length was significant and positive. The total effect of hand length (0.49) on mid position grasp reach length of women was more followed by span (0.45) and normal standing height (0.43). The total effect of mid-shoulder height (0.32), elbow height (0.32) and waist height (0.36) was in the range of 0.32-0.36. The effect of normal standing height (0.28) and hand length (0.45) on mid position grasp length of women was direct, positive and substantial. Whereas, the variables like mid-shoulder height (0.58), elbow height (0.28), waist height (0.40) and span (0.37) were found to have indirect, positive and substantial effect on mid position grasp reach length of women in standing position.

Substantial indirect effect of normal standing height (0.27), mid-shoulder height (0.32), elbow height (0.22), waist height (0.25) and span (0.30) on mid position grasp reach length of women was positive via hand length while the effect of hand length on mid position grasp reach length was negative via mid-shoulder height (-0.18) and positive via normal standing height.

Table 65 Path Analysis Between Standing Static Anthropometry and Mid Position Grasp Reach Length (D_{13}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.43	0.28	0.15	0.27(S_5)	-0.19(S_4)
Mid Shoulder Height (S_4)	0.32	-0.26	0.58	0.32(S_5)	0.21(S_1)
Hand Length (S_5)	0.49	0.45	0.04	-0.18(S_4)	0.17(S_1)
Elbow Height (S_8)	0.32	0.04	0.28	0.22(S_5)	0.19(S_1)
Waist Height (S_{10})	0.36	-0.04	0.40	0.25(S_5)	0.22(S_1)
Span (S_{14})	0.45	0.08	0.37	0.30(S_5)	0.23(S_1)

Thus, it is concluded that normal standing height and hand length were contributing positively in determination of mid position grasp reach length and mid-shoulder height contributed negatively to mid position grasp reach length of women in standing position.

4.5.6 Relationship Between Standing Static Anthropometric Measurements and Lower Position Grasp Reach Length of Women

4.5.6.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Lower Position Grasp Reach Length of Women

Simple correlation and regression analysis between standing static anthropometry and lower position grasp reach length of women is expressed in Table 66 and Figure 47.

As evidenced from the Table the lower position grasp reach length was positively correlated with normal standing height ($r=0.31^{**}$), mid-shoulder height ($r=0.25^{**}$), hand length ($r=0.41^{**}$), elbow height ($r=0.18^{**}$), waist height($r=0.22^{**}$) and span ($r=0.35^{**}$) of women in standing position. These values indicated that the lower position grasp reach length increases with an increase in normal standing height, mid-shoulder height, hand length, elbow height, waist height, and span of women. The per cent impact of hand length, span, and normal standing height on lower position grasp reach length was 17, 12 and 9 per cent respectively. Regression coefficient indicated that one centimeter increase each in static measurements like normal standing height, mid-shoulder height, hand length, elbow height, waist height and span effected in increase of lower position grasp reach length by 0.34,0.23,0.62,0.22,0.29 and0.32 cm respectively.

Table 66 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Lower Position Grasp Reach Length (D_{14}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Normal Standing Height (S_1)	0.31^{**}	0.09	D_{14}=13.30+0.34 S_1
Mid Shoulder Height (S_4)	0.25^{**}	0.06	D_{14}=34.52+0.23 S_4
Hand Length (S_5)	0.41^{**}	0.17	D_{14}=22.01+0.62 S_5
Elbow Height (S_8)	0.18^{**}	0.03	D_{14}=43.35+0.22 S_8
Waist Height (S_{10})	0.22^{**}	0.05	D_{14}=36.96+0.29 S_{10}
Span (S_{14})	0.35^{**}	0.12	D_{14}=14.63+0.32 S_{14}

** Significant at 1 per cent level of significance

4.5.6.2 The Multiple Regression Model of Lower Position Grasp Reach Length of Women With Standing Static Anthropometry

The multiple regression model of lower position grasp reach length of women with standing static anthropometry is presented in Table 67

It is clear from the Table that the selected set of static anthropometry could explain the variation in lower position grasp reach length by 20 per cent. Normal standing height (t=2.93**) and hand length (t=6.44**) contributed significantly and positively to the lower position grasp reach length with partial regression coefficient of 0.29 and 0.63. This explains that one-centimeter increase in normal standing height having other variables constant can cause 0.29cm increase in lower position grasp reach length. Whereas, 0.63 cm increase in lower position grasp reach length was explained with an increase of 1 cm in hand length keeping all other measurements at constant.

Table 67 The Multiple Regression Model of Lower Position Grasp Reach Length (D_{14}) of Women With Standing Static Anthropometry

Anthropometric Variables	**Partial Regression Coefficient (b_i)**	**SE (b_i)**	**t (b_i)**
Normal Standing Height (S_1)	0.29	0.10	2.93**
Mid Shoulder Height (S_4)	-0.16	0.06	-2.54*
Hand Length (S_5)	0.63	0.10	6.44**
Elbow Height (S_8)	-0.07	0.07	-0.95NS
Waist Height (S_{10})	-0.21	0.09	-2.30*
Span (S_{14})	0.10	0.07	1.50NS

B_0=9.95 R^2=0.20 F=21.13**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

Mid-shoulder height (t=-2.54**) and waist height (t=-2.30**) exerted negative effect on lower position grasp reach length of women with partial regression coefficient values of –0.16 and -0.21 indicating that the lower position grasp reach length reduced by 0.16 and 0.21 cm with an increase of one cm each in mid-shoulder height and waist height respectively.

4.5.6.3 Path Analysis Between Standing Static Anthropometry and Lower Position Grasp Reach Length of Women

Path analysis between selected squatting static anthropometry and lower position grasp reach length is demonstrated in Table 68 and Figure 48.

Total effect of selected static anthropometry on lower position grasp reach length of women was significant and positive. Total effect of hand length (0.41), span (0.35) and normal standing height (0.31) was more on lower position grasp reach length of women. The variables like normal standing height (0.27) and hand length (0.42) were having direct, substantial and positive effect on lower position grasp reach length of women in standing position whereas, the effect of mid-shoulder height (0.43), elbow height (0.24), waist height (0.38) and span (0.24) recorded indirect effect on lower position grasp reach length of women in standing position.

Table 68 Path Analysis Between Standing Static Anthropometry and Lower Position Grasp Reach Length (D_{14}) of Women In Standing Position

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.31	0.27	0.04	0.25(S_5)	-0.13(S_4)
Mid Shoulder Height (S_4)	0.25	-0.18	0.43	0.30(S_5)	0.19(S_1)
Hand Length (S_5)	0.41	0.42	-0.01	0.16(S_1)	-0.13(S_4)
Elbow Height (S_8)	0.18	-0.06	0.24	0.20(S_5)	0.18(S_1)
Waist Height (S_{10})	0.22	-0.16	0.38	0.23(S_5)	0.21(S_1)
Span (S_{14})	0.35	0.11	0.24	0.28(S_5)	0.21(S_1)

4.5.7 Relationship Between Standing Static Anthropometric Measurements and Forward Upper Position Arm Reach Length of Women

4.5.7.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Upper Position Arm Reach Length of Women

Simple correlation and regression analysis between standing static anthropometry and forward upper position arm reach length of women is presented in Table 69 and Figure 49.

It is clear from the Table that all selected static anthropometric measurements like normal standing height ($r=0.37^{**}$), mid-shoulder height ($r=0.27^{**}$), hand length ($r=0.24^{**}$), elbow height ($r=0.20^{**}$), waist height ($r=0.22^{**}$) and span ($r=0.35^{**}$) were positively correlated with forward upper position arm reach length of women in standing position. This indicated that the forward upper position arm reach length of women was found to be increased with an increase in selected set of static anthropometric measurements of women.

Values of 'r' square indicated approximately equal effect (13 and 12) of normal standing height and span of women on forward upper position arm reach length. Other static measurements such as mid-shoulder height (7%), hand length (6%), elbow height (4%) and waist height (5%) showed very meager effect on forward upper position arm reach length of women.

Regression coefficient indicated maximum increase of 0.52 cm in forward upper position arm reach length with an increase of 1 cm in normal standing height of women. One centimeter increase in hand length showed an increase of 0.47 cm in forward upper position arm reach length. Mid-shoulder height (0.33), elbow height (0.31), waist height (0.39) and span (0.40) increased the forward upper position reach length in the range of 0.31 to 0.40 cm.

Table 69 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Upper Position Arm Reach Length (D_{15}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.37^{**}	0.13	D_{15}=(-) 4.00+0.52 S_1
Mid Shoulder Height (S_4)	0.27^{**}	0.07	D_{15}=32.10+0.33 S_4
Hand Length (S_5)	0.24^{**}	0.06	D_{15}=42.71+0.47 S_5
Elbow Height (S_8)	0.20^{**}	0.04	D_{15}=44.63+0.31 S_8
Waist Height (S_{10})	0.22^{**}	0.05	D_{15}=38.20+0.39 S_{10}
Span (S_{14})	0.35^{**}	0.12	D_{15}=11.30+0.40 S_{14}

** Significant at 1 per cent level of significance

4.5.7.2 The Multiple Regression Model of Forward Upper Position Arm Reach Length of Women With Standing Static Anthropometry

The multiple regression model of forward upper position arm reach length of women with standing static anthropometry is noted in Table 70

It is evident from the Table that set of static anthropometric measurements included in regression analysis could explain the variation in forward upper position arm reach length to the extent of 17 per cent (R^2=0.17). Normal standing height (t=4.46**) and span (t=2.44*) contributed significantly and positively to the forward upper position arm reach length of women whereas, waist height (t=-2.95**) contributed significantly and negatively to the forward upper position arm reach length of women.

Table 70 The Multiple Regression Model of Forward Upper Position Arm Reach Length (D_{15}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.58	0.13	4.46^{**}
Mid Shoulder Height (S_4)	0.06	0.09	0.68NS
Hand Length (S_5)	-0.01	0.13	-0.13NS
Elbow Height (S_8)	-0.13	0.09	-1.45NS
Waist Height (S_{10})	-0.36	0.12	-2.95^{**}
Span (S_{14})	0.22	0.09	2.44^{*}

B_0= (-) 5.93 R^2=0.17 $F=16.63^{**}$

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

Partial regression coefficient indicated 0.58 cm and 0.22 cm increase in forward upper position arm reach length with an increase of 1 cm each in normal standing height and span respectively. Whereas, the reduction of 0.36 cm in forward upper position arm reach length was noticed with an increase of 1 cm waist height of women in standing position.

4.5.7.3 Path Analysis Between Standing Static Anthropometry and Forward Upper Position Arm Reach Length of Women

Path analysis between selected standing static anthropometry and forward upper position arm reach length is demonstrated in Table 71 and Figure 50.

The total effect of selected static anthropometry on forward upper position arm reach length was substantial, positive and significant. Normal standing height (0.37) showed maximum total effect on forward upper position arm reach length followed by span (0.35) and mid-shoulder height (0.27). The total effect of hand length (0.24), elbow height (0.20) and waist height (0.22) recorded on forward upper position arm reach length of women in standing position was in the range of 0.20-0.24.

Anthropometric measurements like normal standing height (0.41) and span (0.19) exhibited positive, direct and substantial effect on forward upper position arm reach length of women in standing position. Substantial effect of mid-shoulder height (0.22), hand length (0.25), elbow height (0.29) and waist height (0.43) on forward upper position arm reach length of women was indirect and positive.

Table 71 Path Analysis Between Standing Static Anthropometry and Forward Upper Position Arm Reach Length (D_{15}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.37	0.41	-0.04	-0.16(S_{10})	0.15(S_{14})
Mid Shoulder Height (S_4)	0.27	0.05	0.22	0.30(S_1)	-0.13(S_{10})
Hand Length (S_5)	0.24	-0.01	0.25	0.25(S_1)	0.13(S_{14})
Elbow Height (S_8)	0.20	-0.09	0.29	0.29(S_1)	-0.13(S_{10})
Waist Height (S_{10})	0.22	-0.21	0.43	0.33(S_1)	0.13(S_{14})
Span (S_{14})	0.35	0.19	0.16	0.33(S_1)	-0.14(S_{10})

Substantial indirect effect of mid-shoulder height (0.30), hand length (0.25), elbow height (0.29), waist height (0.33), and span (0.33) was noticed on forward upper position length of women through normal standing height. The indirect effect of normal standing height on forward upper position arm reach length was observed to be negative through waist height.

It is concluded from the findings that normal standing height was an important static anthropometric measurement in deciding forward upper position arm reach length of women.

4.5.8 Relationship Between Standing Static Anthropometric Measurements and Forward Mid Position Arm Reach Length of Women

4.5.8.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Mid Position Arm Reach Length of Women

Simple correlation and regression analysis between standing static anthropometry and forward mid position arm reach length of women is illustrated in Table 72 and Figure 51.

The findings from the Table indicate that the selected static measurements like Normal standing height ($r=0.53^{**}$), mid-shoulder height ($r=0.41^{**}$), hand length ($r=0.46^{**}$), elbow height ($r=0.42^{**}$), waist height ($r=0.48^{**}$) and span ($r=0.53^{**}$) were positively correlated with forward mid position arm reach length of women in standing position.

The values of 'r' square indicated 28 per cent effect of normal standing height and span on forward mid position arm reach length of women. The per cent effect of hand length and waist height on forward mid position arm reach length was 21 and 23 per cent respectively. Per cent effect of mid-shoulder height and elbow height was same (17 %) on forward mid position arm reach length of women in standing position. Statistical values of regression coefficient exhibited that one cm increase in Normal standing height, mid-shoulder height, hand length, elbow height, waist height and span increased the forward mid position arm reach length of women by 0.73,0.48,0.89,0.64,0.84, and 0.61 cm respectively.

Table 72 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Mid Position Arm Reach Length (D_{16}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Normal Standing Height (S_1)	0.53^{**}	0.28	D_{16}=(-) 4.36+0.73 S_1
Mid Shoulder Height (S_4)	0.41^{**}	0.17	D_{16}=43.10+0.48 S_4
Hand Length (S_5)	0.46^{**}	0.21	D_{16}=45.12+0.89 S_5
Elbow Height (S_8)	0.42^{**}	0.17	D_{16}=43.06+0.64 S_8
Waist Height (S_{10})	0.48^{**}	0.23	D_{16}=27.10+0.84 S_{10}
Span (S_{14})	0.53^{**}	0.28	D_{16}=10.82+0.61 S_{14}

** Significant at 1% level of significance

4.5.8.2 The Multiple Regression Model of Forward Mid Position Arm Reach Length of Women With Standing Static Anthropometry

The multiple regression model of forward mid position arm reach length of women with standing static anthropometry is depicted in Table 73.

It is clear from the Table that selected static anthropometric measurements could explain the variation in forward mid position arm reach length to the extent of 33 per cent (R^2=0.33). Normal standing height (t=2.42^{*}), hand length (t=3.32^{**}) and span (t=2.75^{**}) of women contributed positively and significantly on forward mid position arm reach length of women and showed that 1 cm increase in normal standing height, hand length and span contributed to the increase of 0.28 cm, 0.38 cm and 0.22cm in forward mid position reach length of women.

Table 73 The Multiple Regression Model of Forward Middle Position Arm Reach Length (D_{16}) of Women With Standing Static Anthropometry

Anthropometric Variables	**Partial Regression Coefficient (b_i)**	**SE (b_i)**	**t (b_i)**
Normal Standing Height (S_1)	0.28	0.11	2.42^{*}
Mid Shoulder Height (S_4)	-0.12	0.08	-1.65NS
Hand Length (S_5)	0.38	0.11	3.32^{**}
Elbow Height (S_8)	0.14	0.08	1.68NS
Waist Height (S_{10})	0.16	0.11	1.49NS
Span (S_{14})	0.22	0.08	2.75^{**}

B_0= (-) 8.54 R^2=0.33 $F=41.53^{**}$

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.5.8.3 Path Analysis Between Standing Static Anthropometry and Forward Mid Position Arm Reach Length of Women

Path analysis between selected standing static anthropometry and forward mid position arm reach length is depicted in Table 74 and Figure 52.

It is obvious from the Table that the total effect of all selected static anthropometry on forward mid position arm reach length of women was significant, substantial and positive. The total effect of normal standing height (0.53), and span (0.67) on forward mid position arm reach length of women was more and equal followed by the total effect of waist height (0.48) and hand length (0.46). Approximately equal effect of mid-shoulder height (0.41) and elbow height (0.42) noticed on forward mid position arm reach length of women in standing position.

The distribution of direct and indirect effect of static anthropometry on forward mid position length indicated that normal standing height (0.33), mid-shoulder height (0.52), hand length (0.26), elbow height (0.33), waist height (0.39) and span (0.34) were having more indirect effect on forward mid position arm reach length of women in standing position than direct effect.

Table 74 Path Analysis Between Standing Static Anthropometry and Forward Middle Position Arm Reach Length (D_{16}) of Women

Anthropometric Variables	**Total Effect**	**Direct Effect**	**Indirect Effect**	**Substantial Indirect Effect (I)**	**Substantial Indirect Effect (II)**
Normal Standing Height (S_1)	0.53	0.20	0.33	0.15(S_{14})	0.12(S_5)
Mid Shoulder Height (S_4)	0.41	-0.11	0.52	0.15(S_1)	0.14(S_5)
Hand Length (S_5)	0.46	0.20	0.26	0.13(S_{14})	0.12(S_1)
Elbow Height (S_8)	0.42	0.09	0.33	0.14(S_1)	0.10(S_{14})
Waist Height (S_{10})	0.48	0.09	0.39	0.16(S_1)	0.13(S_{14})
Span (S_{14})	0.53	0.19	0.34	0.16(S_1)	0.13(S_5)

Substantial indirect effect of selected static measurements on forward mid position arm reach length of women indicated that normal standing height was having indirect effect on forward mid position arm reach length through span (0.15) and hand length (0.12) whereas, mid-shoulder height (0.15, 0.14) and span (0.16, 0.13) showed indirect effect on forward mid position arm reach length via normal standing height and hand length of women. The indirect effect of hand length (0.13; 0.12), elbow height (0.14; 0.10) and waist height (0.16; 0.13) was recorded on forward mid position arm reach length of women through normal standing height and span of women in standing position.

It can be concluded from the findings that normal standing height, span and hand length contributes in determination of forward mid position arm reach length of women in standing position.

4.5.9 Relationship Between Standing Static Anthropometric Measurements and Forward Lower Position Arm Reach Length of Women

4.5.9.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Lower Position Arm Reach Length of Women

Simple correlation and regression analysis between standing static anthropometry and forward lower position arm reach length of women is depicted in Table 75 and Figure 53.

Table 75 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Lower Position Arm Reach Length (D_{17}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.09NS	0.008	D_{17}=27.27+0.17 S_1
Mid Shoulder Height (S_4)	0.02NS	0.0004	D_{17}=49.33+0.03 S_4
Hand Length (S_5)	-0.03NS	0.0007	D_{17}=58.51-0.07 S_5
Elbow Height (S_8)	-0.03NS	0.0007	D_{17}=59.16-0.05 S_8
Waist Height (S_{10})	-0.06NS	0.003	D_{17}=67.43-0.14 S_{10}
Span (S_{14})	0.09NS	0.008	D_{17}=29.85+0.15 S_{14}

NS Non significant

As evidenced from the Table there was no correlation between the forward lower position arm reach length and normal standing height, mid-shoulder height, hand length, elbow height, waist height and span of women in standing position.

4.5.9.2 The Multiple Regression Model of Forward Lower Position Arm Reach Length of Women With Standing Static Anthropometry

The multiple regression model of forward lower position arm reach length of women with standing static anthropometry is presented in Table 76

It is clear from the Table that the selected set of static anthropometry could explain the variation in forward lower position arm reach length by very low per cent (R^2=0.07). Normal standing height (t=3.22**) and span (t=2.51*) contributed significantly and positively to the forward lower position arm reach length with partial regression coefficient of 0.60 and 0.32.

Table 76 The Multiple Regression Model of Forward Lower Position Arm Reach Length (D_{17}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (bi)
Normal Standing Height (S_1)	0.60	0.18	3.22**
Mid Shoulder Height (S_4)	0.07	0.12	0.61NS
Hand Length (S_5)	-0.39	0.19	-2.11*
Elbow Height (S_8)	-0.23	0.13	-1.72NS
Waist Height (S_{10})	-0.79	0.17	-4.50**
Span (S_{14})	0.32	0.13	2.51*

B_0=26.31 R^2=0.07 F=6.66**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

Partial regression coefficient values explain that one centimeter increase in normal standing height having other variables constant can cause 0.60 cm increase in forward lower position arm reach length whereas, 0.32 cm increase in forward lower position arm reach length was explained with an increase of 1 cm in span keeping all other measurements at constant. Waist height (t=-4.50**)

exerted negative effect on forward lower position arm reach length of women with partial regression coefficient values of –0.79 indicating that the forward lower position arm reach length decreased by 0.79 cm with an increase of one cm in waist height.

4.5.9.3 Path Analysis Between Standing Static Anthropometry and Forward Lower Position Arm Reach Length of Women

Path analysis between selected standing static anthropometry and forward lower position arm reach length is presented in Table 77 and Figure 54.

It is clear from the Table that the total correlation of the selected static anthropometric measurements of women in standing position with forward lower position arm reach length was non significant.

Further it is clear from the Table that the direct effect of normal standing height of women was positive and more (0.32) on forward lower position arm reach length of women in standing position than the indirect effect. Waist height (-0.33) and span (-0.23) contributed negatively with forward lower position arm reach length of women in standing position.

The indirect effect of normal standing height via waist height was negative and via span was positive on forward lower position arm reach length of women in standing position. The indirect effect of mid-shoulder height (0.23), hand length (0.19), elbow height (0.22) and span (0.25) of women on forward lower position arm reach length via normal standing height was substantial and positive whereas, the indirect effect via waist height was negative.

Table 77 Path Analysis Between Standing Static Anthropometry and Forward Lower Position Arm Reach Length (D_{17}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.09	0.32	-0.23	-0.26(S_{10})	0.16(S_{14})
Mid Shoulder Height (S_4)	0.02	0.05	-0.03	0.23(S_1)	-0.21(S_{10})
Hand Length (S_5)	-0.03	-0.15	0.12	0.19(S_1)	-0.18(S_{10})
Elbow Height (S_8)	-0.03	-0.11	0.08	0.22(S_1)	-0.21(S_{10})
Waist Height (S_{10})	-0.06	-0.33	0.27	0.25(S_1)	0.14(S_{14})
Span (S_{14})	0.09	-0.23	0.14	0.25(S_1)	-0.23(S_{10})

In general it can be inferred that though the total effect of selected static anthropometric measurements on forward lower position arm reach length was non significant normal standing height, waist height and span are important static anthropometric measurements affecting lower position arm reach length of women in standing position.

4.5.10 Relationship Between Standing Static Anthropometric Measurements and Forward Upper Position Grasp Reach Length of Women

4.5.10.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Upper Position Grasp Reach Length of Women

Simple correlation and regression analysis between standing static anthropometry and forward upper position grasp reach length of women is presented in Table 78 and Figure 55.

It is clear from the Table that all selected static anthropometric measurements like normal standing height ($r=0.35^{**}$), mid-shoulder height ($r=0.23^{**}$), hand length ($r=0.19^{**}$), elbow height ($r=0.17^{**}$), waist height ($r=0.17^{**}$) and span ($r=0.31^{**}$) were positively correlated with forward upper position grasp reach length of women in standing position. This indicated that the forward upper position grasp reach length of women was found to be increased with an increase in selected set of static anthropometric measurements of women.

Table 78 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Upper Position Grasp Reach Length (D_{21}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}= a+bx$)
Normal Standing Height (S_1)	0.35^{**}	0.12	D_{21}=(-) 6.89+0.50 S_1
Mid Shoulder Height (S_4)	0.23^{**}	0.05	D_{21}=31.95+0.28 S_4
Hand Length (S_5)	0.19^{**}	0.03	D_{21}=42.68+0.38 S_5
Elbow Height (S_8)	0.17^{**}	0.03	D_{21}=42.32+0.27 S_8
Waist Height (S_{10})	0.17^{**}	0.03	D_{21}=40.11+0.30 S_{10}
Span (S_{14})	0.31^{**}	0.09	D_{21}=11.35+0.36 S_{14}

** Significant at 1 per cent level of significance

Values of 'r' square indicated 12 per cent effect normal standing height and 9 per cent effect of span of women on forward upper position grasp reach length of women. Other static measurements such as mid-shoulder height (5 %), hand length; elbow height and waist height (3 % each) showed very meager effect on forward upper position grasp reach length of women.

Regression coefficient indicated maximum increase of 0.50 cm in forward upper position grasp reach length with an increase of 1 cm in normal standing height of women. One centimeter increase in hand length showed an increase of 0.38 cm in forward upper position grasp reach length. One-centimeter increase of mid-shoulder height (0.28), Elbow height (0.27) and waist height (0.30) increased the forward upper position grasp reach length in the range of 0.27 - 0.30cm.

4.5.10.2 The Multiple Regression Model of Forward Upper Position Grasp Reach Length of Women With Standing Static Anthropometry

The multiple regression model of forward upper position grasp reach length of women with standing static anthropometry is depicted in Table 79.

It is evident from the Table that set of static anthropometric measurements included in regression analysis could explain the variation in forward upper position grasp reach length to the extent of 16 per cent (R^2=0.16). Normal standing height (t=5.53**) and Span (t=1.98*) contributed significantly and positively to the forward upper position grasp reach length of women whereas, waist height (t=-4.00**) contributed significantly and negatively to the forward upper position grasp reach length of women.

Table 79 The Multiple Regression Model of Forward Upper Position Grasp Reach Length (D_{21}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.74	0.13	5.53**
Mid Shoulder Height (S_4)	0.02	0.09	0.24NS
Hand Length (S_5)	-0.06	0.13	-0.47NS
Elbow Height (S_8)	-0.14	0.09	-1.54NS
Waist Height (S_{10})	-0.50	0.12	-4.00**
Span (S_{14})	0.18	0.09	1.98*

B_0= (-) 8.07 R^2=0.16 F=15.89**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

Partial regression coefficient indicated 0.74 cm and 0.18 cm increase in forward upper position grasp reach length with an increase of 1 cm each in normal standing height and span respectively whereas, the reduction of 0.50 cm in forward upper position grasp reach length was noticed with an increase of 1 cm waist height of women in standing position.

4.5.10.3 Path Analysis Between Standing Static Anthropometry and Forward Upper Position Grasp Reach Length of Women

Path analysis between selected standing static anthropometry and forward upper position grasp reach length is illustrated in Table 80 and Figure 56.

It is clear from the Table that the total effect of selected static anthropometry on forward upper position grasp reach length was positive and significant. Maximum effect on forward upper position grasp reach length was recorded by normal standing height (0.35), span (0.31) and mid-shoulder height (0.23). Approximately similar effect of hand length (0.19), elbow height (0.17) and waist height (0.17) was noted on forward upper position grasp reach length of women in standing position.

Effect of normal standing height (0.52) on forward upper position grasp reach length of women was direct and maximum whereas, effect of waist height (0.45) on forward upper position grasp reach length was indirect. Indirect effect of mid-shoulder height (0.21), hand length (0.22), elbow height (0.26) and span (0.16) was more on forward upper position grasp reach length than their direct effect.

Table 80 Path Analysis Between Standing Static Anthropometry and Forward Upper Position Grasp Reach Length (D_{21}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.35	0.52	0.17	-0.22(S_{10})	0.12(S_{14})
Mid Shoulder Height (S_4)	0.23	0.02	0.21	0.37(S_1)	-0.18(S_{10})
Hand Length (S_5)	0.19	-0.03	0.22	0.31(S_1)	-0.16(S_{10})
Elbow Height (S_8)	0.17	-0.09	0.26	0.36(S_1)	-0.18(S_{10})
Waist Height (S_{10})	0.17	-0.28	0.45	0.41(S_1)	0.11(S_{14})
Span (S_{14})	0.31	0.15	0.16	0.41(S_1)	-0.20(S_{10})

Substantial indirect effect of normal standing height on forward upper position grasp reach length via waist height (-0.22) was negative and via span (0.12) was positive. Substantial indirect effect of mid-shoulder height (0.37), hand length (0.31), elbow height (0.36) and span (0.41) via normal standing height was positive and via waist height the effect was negative. Substantial effect of waist height on forward upper position grasp reach length was more via normal standing height (0.41) followed by span (0.11) of women in standing position.

Thus, it can be said that normal standing height had positive effect and waist height had negative effect on forward upper position grasp reach length of women in standing position.

4.5.11 Relationship Between Standing Static Anthropometric Measurements and Forward Mid Position Grasp Reach Length of Women

4.5.11.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Mid Position Grasp Reach Length of Women

Simple correlation and regression analysis between standing static anthropometry and forward mid position grasp reach length of women is reported in Table 81 and depicted in Figure 57.

The findings from the Table indicated that the selected static measurements like Normal standing height ($r=0.51^{**}$), mid-shoulder height ($r=0.37^{**}$), hand length ($r=0.43^{**}$), elbow height ($r=0.37^{**}$), waist height ($r=0.43^{**}$) and span ($r=0.53^{**}$) were positively correlated with forward mid position grasp reach length of women in standing position.

Table 81 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Mid Position Grasp Reach Length (D_{22}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Normal Standing Height (S_1)	0.51^{**}	0.26	$D_{22}=-9.44+0.71\ S_1$
Mid Shoulder Height (S_4)	0.37^{**}	0.13	$D_{22}=39.37+0.45\ S_4$
Hand Length (S_5)	0.43^{**}	0.18	$D_{22}=39.92+0.85\ S_5$
Elbow Height (S_8)	0.37^{**}	0.13	$D_{22}=41.36+0.57\ S_8$
Waist Height (S_{10})	0.43^{**}	0.18	$D_{22}=26.4+0.76\ S_{10}$
Span (S_{14})	0.53^{**}	0.28	$D_{22}=2.14+0.61\ S_{14}$

** Significant at 1% level of significance

The values of ‘r’ square indicated 28 per cent effect of span and 26 per cent effect of normal standing height on forward mid position grasp reach length of women. The per cent effect of hand length and waist height on forward mid position grasp reach length was found to be equal (18 %). Per cent effect of mid-shoulder height and elbow height was same (13 %) on forward mid position grasp reach length of women in standing position.

Statistical values of regression coefficient exhibited that one centimeter increase in Normal standing height, mid-shoulder height, hand length, elbow height, waist height and span increased the forward mid position grasp reach length of women by 0.71, 0.45, 0.85, 0.57, 0.76 and 0.61 cm respectively.

4.5.11.2 The Multiple Regression Model of Forward Mid Position Grasp Reach Length of Women With Standing Static Anthropometry

The multiple regression model of forward mid position grasp reach length of women with standing static anthropometry is depicted in Table 82.

It is clear from the Table that selected static anthropometric measurements could explain the variation in forward mid position grasp reach length to the extent of 31 per cent (R^2=0.31). Normal standing height ($t=2.94^{**}$), hand length ($t=2.85^{**}$) and span ($t=3.66^{**}$) of women contributed positively and significantly on forward mid position grasp reach length of women and showed that 1 cm increase in normal standing height, hand length and span contributed to an increase of 0.34cm, 0.33cm and 0.29cm in forward mid position grasp reach length of women respectively.

Table 82 The Multiple Regression Model of Forward Mid Position Grasp Reach Length (D_{22}) of Women With Standing Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Normal Standing Height (S_1)	0.34	0.12	2.94**
Mid Shoulder Height (S_4)	-0.13	0.08	-1.74NS
Hand Length (S_5)	0.33	0.12	2.85**
Elbow Height (S_8)	0.06	0.08	0.80NS
Waist Height (S_{10})	0.01	0.11	0.09NS
Span (S_{14})	0.29	0.08	3.66**

B_0= (-) 13.93 R^2=0.31 F=37.26**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.5.11.3 Path Analysis Between Standing Static Anthropometry and Forward Mid Position Grasp Reach Length of Women

Path analysis between selected standing static anthropometry and forward mid position grasp reach length is depicted in Table 83 and Figure 58.

It is obvious from the Table that the total effect of selected static anthropometry on forward mid position grasp reach length of women was positive and significant. Span (0.53) and normal standing height (0.51) showed maximum total effect on forward mid position grasp reach length of women in standing position followed by equal effect of hand length and waist height (0.43 each) and mid-shoulder height and elbow height (0.37 each). All the selected static anthropometric measurements like normal standing height (0.26), mid-shoulder height (0.48), hand length (0.26), elbow height (0.33), waist height (0.42) and span (0.27) indicated an indirect effect on forward mid position grasp reach length of women than the direct effect.

Table 83 Path Analysis Between Standing Static Anthropometry and Forward Middle Position Grasp Reach Length (D_{22}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.51	0.25	0.26	0.21(S_{14})	0.10(S_5)
Mid Shoulder Height (S_4)	0.37	-0.11	0.48	0.18(S_1)	0.16(S_{14})
Hand Length (S_5)	0.43	0.17	0.26	0.17(S_{14})	0.15(S_1)
Elbow Height (S_8)	0.37	0.04	0.33	0.17(S_1)	0.14(S_{14})
Waist Height (S_{10})	0.43	0.01	0.42	0.20(S_1)	0.18(S_{14})
Span (S_{14})	0.53	0.26	0.27	0.20(S_1)	0.12(S_5)

The effect of normal standing height (0.21) and hand length (0.17) on forward mid position grasp reach length was recorded through span while the effect of mid-shoulder height (0.18), elbow height (0.17), waist height (0.20) and span (0.20) on forward mid position grasp reach length was noticed via normal standing height.

Thus, it is concluded that forward mid position grasp reach length of women gets affected by normal standing height and span followed by hand length of women in standing position.

4.5.12 Relationship Between Standing Static Anthropometric Measurements and Forward Lower Position Grasp Reach Length of Women

4.5.12.1 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Lower Position Grasp Reach Length of Women

Simple correlation and regression analysis between standing static anthropometry and forward lower position grasp reach length of women is depicted in Table 84 and presented in Figure 59.

It is evident from the Table there was no correlation between the forward lower position grasp reach length and normal standing height, mid-shoulder height, hand length, elbow height, waist height and span of women in standing position.

Table 84 Simple Correlation and Regression Analysis Between Standing Static Anthropometry and Forward Lower Position Grasp Reach Length (D_{23}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Normal Standing Height (S_1)	0.09NS	0.006	D_{23}=25.46+0.16 S_1
Mid Shoulder Height (S_4)	0.02NS	0.0003	D_{23}=46.24+0.03 S_4
Hand Length (S_5)	-0.03NS	0.001	D_{23}=55.65-0.08 S_5
Elbow Height (S_8)	-0.03NS	0.0007	D_{23}=55.55-0.06 S_8
Waist Height (S_{10})	-0.06NS	0.003	D_{23}=62.57-0.13 S_{10}
Span (S_{14})	0.10*	0.01	D_{23}=25.28+0.15 S_{14}

* Significant at 5% level of significance NS Non significant

4.5.12.2 The Multiple Regression Model of Forward Lower Position Grasp Reach Length of Women With Standing Static Anthropometry

The multiple regression model of forward lower position grasp reach length of women with standing static anthropometry is presented in Table 85

It is clear from the Table that the selected set of static anthropometry could explain the variation in forward lower position grasp reach length by very low per cent (R^2=0.07). Normal standing height (t=2.69**) and span (t=2.78**) contributed significantly and positively to the forward lower position grasp reach length with partial regression coefficient of 0.52 and 0.37. This explains that one centimeter increase in normal standing height having other variables constant can cause 0.52 cm increase in forward lower position grasp reach length whereas, 0.37 cm increase in forward lower position grasp reach length was explained with an increase of 1 cm in span keeping all other measurements at constant. Waist height (t=-4.91**) exerted negative effect on forward lower position grasp reach length of women with partial regression coefficient values of -0.74 indicating that the forward lower position grasp reach length gets reduced by 0.74 centimeter with an increase of one cm in waist height.

Table 85 The Multiple Regression Model of Forward Lower Position Grasp Reach Length (D_{23}) of Women With Standing Static Anthropometry

Anthropometric Variables	**Partial Regression Coefficient (b_i)**	**SE (b_i)**	**t (b_i)**
Normal Standing Height (S_1)	0.52	0.17	2.69**
Mid Shoulder Height (S_4)	0.09	0.11	0.14NS
Hand Length (S_5)	-0.44	0.17	-1.06NS
Elbow Height (S_8)	-0.22	0.12	0.90NS
Waist Height (S_{10})	-0.74	0.35	-4.91**
Span (S_{14})	0.37	0.13	2.78**

B_0=24.20 R^2=0.07 F=6.79**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.5.12.3 Path Analysis Between Standing Static Anthropometry and Forward Lower Position Grasp Reach Length of Women

Path analysis between selected standing static anthropometry and forward lower position grasp reach length of women is depicted in Table 86 and Figure 60.

It is evident from the Table that total effect of all selected anthropometric measurements on forward lower position grasp reach length was non significant except for the effect of span (0.10) which was significant at 5 per cent level of significance.

Table 86 Path Analysis Between Standing Static Anthropometry and Forward Lower Position Grasp Reach Length (D_{23}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Normal Standing Height (S_1)	0.09	0.28	-0.19	-0.25(S_{10})	0.19(S_{14})
Mid Shoulder Height (S_4)	0.02	0.06	-0.04	0.20(S_1)	-0.20(S_{10})
Hand Length (S_5)	-0.03	-0.17	0.14	-0.18(S_{10})	0.17(S_1)
Elbow Height (S_8)	-0.03	-0.11	0.08	-0.20(S_{10})	0.19(S_1)
Waist Height (S_{10})	-0.06	-0.32	0.26	-0.32(S_{14})	0.22(S_1)
Span (S_{14})	0.10	0.24	-0.14	0.22(S_1)	-0.22(S_{10})

The direct effect of normal standing height (0.28) and span (0.24) was more and positive on forward lower position grasp length of women while waist height (-0.32) recorded negative substantial direct effect on forward lower position grasp reach length of women. Indirect effect of waist height (0.26) on forward lower position grasp reach length of women was more and positive followed by hand length (0.14)

Substantial indirect effect of normal standing height (-0.25), hand length (-0.18), elbow height (-0.20) and span (-0.32) through waist height on forward lower position grasp reach length was negative and the indirect effect of mid-shoulder height and span through normal standing height was positive.

Thus, it is concluded that the indirect effect of normal standing height on the forward lower position grasp reach length of women was positive and waist height was negative.

On the whole it can be said that natural movements of human body do occur especially in the arms with shoulder joints and elbow joints providing extensive angular freedom. Movements of the body trunk occur mostly in flexion and extension at the lower back or waist point of the body. Findings of the investigation have indicated that the selected set of standing static measurements exerted more than 50 per cent positive effect on majority of vertical dynamic measurements like vertical upward arm reach, vertical upward grasp reach, upper position height, mid position height, forward upper position height followed by forward upper position grasp height and mid position grasp height. The reason may be attributed to the fact that standing height has positive relation with majority of static body dimensions and that is how the vertical segments have longer dimensions with higher stature thus, increasing the vertical reach measurements. The total effect of standing static measurements was meager on lower position reach heights of women in standing position. The reason may be related to the fact that the waist height and ability of flexion at waist point is related with the body dimensions like abdominal girth and arm circumference. Thus, the hidden dimensions may be contributing in deciding the lower position height of women in standing position. On the whole normal standing height, waist height and span exerted substantial indirect effect on majority of vertical anthropometry of women in standing position.

The total effect of selected set of standing static anthropometry on horizontal dynamic anthropometry was between 16 and 34 per cent, which was less than the total effect of standing static anthropometry on vertical dynamic anthropometry of women. The contributing static measurements recorded were hand length and normal standing height .The reason may be due to that the taller person always has longer hands and longer the hand it can be extended more in horizontal plane.

Statistical findings from the present study are in confirmation with the findings of Sumangala (1995) and Sumangala and Ogale (1996) that elbow height and elbow length as well as span has a positive significant relationship with horizontal reach measurements of worker.

4.6 Relationship Between Squatting Static and Dynamic Anthropometry of Women

Initially the study included total 11 squatting static measurements, which were denoted as independent variables. Dynamic measurements considered, as dependant variables in the study were vertical and horizontal reach measurements of women in squatting position. Depending upon logistic approach, significance of actual correlation and theoretical importance of positions of body measurements 4 out of 11 squatting static measurements were considered for final multiple regression analysis. The independent variables selected were hand length (S_5), normal squatting height (S_{24}), squatting mid-shoulder height (S_{26}) and right knee height (S_{27}). The variables selected were adequate and sufficient to describe the phenomena of squatting dynamic anthropometry of women.

4.6.1 Relationship Between Squatting Static Anthropometry and Vertical Arm Reach of Women

4.6.1.1 Simple Correlation and Regression Analysis Between Squatting Static Measurements and Vertical Arm Reach of Women

Simple correlation and regression analysis between squatting static anthropometry and vertical arm reach of women is illustrated in Table 87 and Figure 61.

It is clear from the Table that vertical arm reach of women in squatting position is positively related with hand length (0.43^{**}), normal squatting height ($r=0.69^{**}$), mid-shoulder height ($r=0.62^{**}$) and right knee height (0.26^{**}). These findings indicated that the vertical arm reach of women in squatting posture increases with an increase in hand length, normal squatting height, mid-shoulder height and right knee height in squatting position.

Table 87 Simple Correlation and Regression Analysis Between Squatting Static Anthropometry and Vertical Arm Reach (D_{27}) of Women.

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}= a+bx$)
Hand Length (S_5)	0.43^{**}	0.18	$D_{27}=88.02+0.60S_5$
Normal Squatting Height (S_{24})	0.69^{**}	0.47	$D_{27}=54.98+0.87\ S_{24}$
Mid Shoulder Height (S_{26})	0.62^{**}	0.38	$D_{27}=73.62+0.83\ S_{26}$
Right Knee Height (S_{27})	0.26^{**}	0.07	$D_{27}=111.6+0.41\ S_{27}$

** Significant at 1 per cent level of significance

The per cent effect on vertical arm reach as indicated by values of 'r' square was 47 and 38 by normal squatting height and mid-shoulder height of women respectively. Hand length and right knee height indicated less effect on vertical arm reach of women in squatting posture.

Regression analysis indicated 0.87 cm and 0.83 cm increase in vertical arm reach of women in squatting posture with an increase of 1 cm in normal squatting height and mid-shoulder height respectively. The increase in vertical arm reach was 0.60 and 0.41 cm with an increase of one centimeter in hand length and right knee height respectively.

4.6.1.2 The Multiple Regression Model of Vertical Arm Reach of Women With Squatting Static Anthropometry

The multiple regression model of vertical arm reach of women with squatting static anthropometry is expressed in Table 88

It is obvious from the Table that the selected set of static anthropometry could explain variation in vertical arm reach of women in squatting posture by 58 per cent. Hand length ($t=8.03^{**}$), normal squatting height ($t=10.54^{**}$), mid-shoulder height ($t=5.41^{**}$) and right knee height ($t=2.10^{*}$) contributed positively and significantly to vertical arm reach of women in squatting posture. Partial regression coefficient indicated that one centimeter increase in hand length, normal squatting height can cause an increase of 0.35 and 0.57 cm in vertical arm reach when other measurements are constant. The centimeter increase of 0.31in vertical arm reach was noticed with an increase of 1 cm in mid-shoulder height, which was 0.10 cm in case of right knee height.

Table 88 The Multiple Regression Model of Vertical Arm Reach (D_{27}) of Women With Squatting Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Hand Length (S_5)	0.35	0.004	8.03^{**}
Normal Squatting Height (S_{24})	0.57	0.054	10.54^{**}
Mid Shoulder Height (S_{26})	0.31	0.057	5.41^{**}
Right Knee Height (S_{27})	0.10	0.049	2.10^{*}

B_0=30.32 R^2= 0.58 F= 172.19^{**}

** Significant at 1% level of significance * Significant at 5% level of significance

4.6.1.3 Path Analysis Between Squatting Static Anthropometry and Vertical Arm Reach of Women

Path analysis between selected squatting static anthropometry and vertical arm reach of women is presented in Table 89 and Figure 62.

It is clear from the Table that total effect of normal squatting height (0.69) and mid-shoulder height (0.62) was positive and significant on vertical arm reach of women in squatting position followed by hand length (0.43) and right knee height (0.26). The direct effect of normal squatting height (0.45) and hand length (0.25) and right knee height (0.20) was more than indirect effect where as the indirect effect of mid-shoulder height (0.39) was more on vertical arm reach of women in squatting position.

Substantial indirect effect of mid-shoulder height (0.33) via normal squatting height was more and positive on vertical arm reach of women in squatting position followed by the effect of normal squatting height via mid-shoulder height (0.17). The effect of right knee height through hand length was meager on vertical arm reach of women in squatting position.

Table 89 Path Analysis Between Squatting Static Anthropometry and Vertical Arm Reach (D_{27}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Hand Length (S_5)	0.43	0.25	0.18	0.10(S_{24})	0.04(S_{26})
Normal Squatting Height (S_{24})	0.69	0.45	0.24	0.17(S_{26})	0.06(S_5)
Mid Shoulder Height (S_{26})	0.62	0.23	0.39	0.33(S_{24})	0.05(S_5)
Right Knee Height (S_{27})	0.26	0.06	0.20	0.09(S_5)	0.06(S_{24})

Thus, it can be said that normal squatting height and mid-shoulder height contributes to the vertical arm reach of women in squatting position.

4.6.2 Relationship Between Squatting Static Anthropometry and Vertical Grasp Reach of Women

4.6.2.1 Simple Correlation and Regression Analysis Between Squatting Static Measurements and Vertical Grasp Reach of Women

Simple correlation and regression analysis between squatting static anthropometry and vertical grasp reach of women is illustrated in Table 90 and Figure 63.

It is clear from the Table that vertical arm grasp reach of women in squatting position is positively related with hand length (0.29^{**}), normal squatting height($r=0.50^{**}$), mid-shoulder height($r=0.45^{**}$) and right knee height (0.17^{**}). These findings indicated that the vertical arm grasp reach of women in squatting posture increases with an increase in hand length, normal squatting height, mid-shoulder height and right knee height in squatting position. The per cent effect on vertical arm grasp reach as indicated by values of 'r' square was 25 and 20 by normal squatting height and mid-shoulder height of women. Hand length (8%) and right knee height (3%) indicated a meager per cent effect on vertical arm grasp reach of women in squatting posture.

Table 90 Simple Correlation and Regression Analysis Between Squatting Static Anthropometry and Vertical Grasp Reach (D_{28}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Hand Length (S_5)	0.29^{**}	0.08	D_{28}=86.25+0.51 S_5
Normal Squatting Height (S_{24})	0.50^{**}	0.25	D_{28}= 54.62+0.78 S_{24}
Mid Shoulder Height (S_{26})	0.45^{**}	0.20	D_{28}=71.12+0.75 S_{26}
Right Knee Height (S_{27})	0.17^{**}	0.03	D_{28}=107.1+0.33 S_{27}

** Significant at 1% level of significance

Regression analysis indicated 0.78 cm and 0.75 cm increase in vertical arm grasp reach of women in squatting posture with an increase of 1 cm in normal squatting height and mid-shoulder height respectively. The increase in vertical arm reach was 0.51 and 0.33 cm with an increase of one centimeter in hand length and right knee height respectively.

4.6.2.2 The Multiple Regression Model of Vertical Grasp Reach of Women With Squatting Static Anthropometry

The multiple regression model of vertical grasp reach of women with squatting static anthropometry is expressed in Table 91

It is obvious from Table that the selected set of static anthropometry could explain variation in vertical grasp reach of women in squatting posture by 30 per cent. Hand length (t= 4.22^{**}), normal squatting height (t=5.89^{**}) and mid-shoulder height ($t=3.2^{**}$) contributed positively and significantly to vertical grasp reach of women in squatting posture.

Table 91 The Multiple Regression Model of Vertical Grasp Reach (D_{28}) of Women With Squatting Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Hand Length (S_5)	0.30	0.07	4.22^{**}
Normal Squatting Height (S_{24})	0.51	0.087	5.89^{**}
Mid Shoulder Height (S_{26})	0.29	0.091	3.2^{**}
Right Knee Height (S_{27})	0.06	0.078	0.77NS

$B_0=34.56$ $R^2= 0.30$ $F=53.15^{**}$

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

Partial regression coefficient indicated that one-centimeter increase in normal squatting height could cause an increase of 0.51 cm in vertical arm grasp reach when other measurements are constant. Approximately an equal increase of 0.30 and 0.29 cm in vertical grasp reach was noticed with an increase of 1 cm in hand length and mid-shoulder height respectively.

4.6.2.3 Path Analysis Between Squatting Static Anthropometry and Vertical Grasp Reach of Women

Path analysis between selected squatting static anthropometry and vertical grasp reach of women in squatting position is presented in Table 92 and Figure 64.

It is apparent from the Table that total effect of normal squatting height (0.50) and mid-shoulder height (0.45) was positive and significant on vertical grasp reach of women in squatting position followed by the total effect of hand length (0.29) and right knee height (0.17). The effect of hand length (0.17) and normal squatting height (0.32) on vertical grasp reach of women in squatting position was more and direct while the indirect effect of mid-shoulder height (0.27) was more on vertical grasp reach of women in squatting posture.

Table 92 Path Analysis Between Squatting Static Anthropometry and Vertical Grasp Reach (D_{28}) of Women

Anthropometric Variables	**Total Effect**	**Direct Effect**	**Indirect Effect**	**Substantial Indirect Effect (I)**	**Substantial Indirect Effect (II)**
Hand Length (S_5)	0.29	0.17	0.12	0.07(S_{24})	0.03(S_{26})
Normal Squatting Height (S_{24})	0.50	0.32	0.18	0.13(S_{26})	0.04(S_5)
Mid Shoulder Height (S_{26})	0.45	0.18	0.27	0.24(S_{24})	0.03(S_5)
Right Knee Height (S_{27})	0.17	0.03	0.14	0.06(S_5)	0.03(S_{24})

Substantial indirect effect of mid-shoulder height via normal squatting height and normal squatting height via mid-shoulder height on vertical grasp reach of women in squatting position was 0.24 and 0.13 respectively. Thus, it can be said that normal squatting height and squatting mid-shoulder height contributes to the vertical upward grasp reach of women in squatting position.

4.6.3 Relationship Between Squatting Static Anthropometry and Upper Position Arm Reach Length of Women

4.6.3.1 Simple Correlation and Regression Analysis Between Squatting Static Measurements and Upper Position Arm Reach Length of Women

Simple correlation and regression analysis between squatting static anthropometry and upper position arm reach length of women is presented in Table 93 and Figure 65.

It is evident from the Table that only squatting mid-shoulder height ($r=-0.16^{**}$) was negatively correlated with upper position arm reach length of women in squatting posture which indicated that as the squatting mid-shoulder height increases the upper position arm reach length of women in squatting posture decreases. Value of 'r' square indicated meager effect of mid-shoulder height (2 %) on upper position arm reach length of women in squatting posture. Regression coefficient indicated 0.32 cm decrease in upper position length of women with an increase of one centimeter in mid-shoulder height.

Table 93 Simple Correlation and Regression Analysis Between Squatting Static Anthropometry and Upper Position Arm Reach Length (D_{29}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Hand Length (S_5)	0.01NS	0.0001	D_{29}=54.76+0.02 S_5
Normal Squatting Height (S_{24})	0.03NS	0.001	D_{29}=50.27+0.067S_{24}
Mid Shoulder Height (S_{26})	-0.16^{**}	0.025	D_{29}=77.5-0.32 S_{26}
Right Knee Height (S_{27})	0.098NS	0.009	D_{29}=66.23-0.23 S_{27}

** Significant at 1% level of significance NS Non significant

4.6.3.2 The Multiple Regression Model of Upper Position Arm Reach Length of Women With Squatting Static Anthropometry

The multiple regression model of upper position arm reach length of women with squatting static anthropometry is presented in Table 94

It is seen from the Table that the set of selected anthropometric measurements could explain the variation in upper position arm reach length by only 8 per cent. Normal squatting height ($t=4.90^{**}$) contributed positively and significantly to upper position arm reach length whereas, squatting mid-shoulder height ($t= -5.93^{**}$) contributed significantly and negatively to upper position arm reach length of women in squatting posture. Partial regression coefficient indicated 0.60 cm increase and 0.75 cm decrease in upper position arm reach length with an increase of one centimeter in normal squatting height and mid-shoulder height respectively.

Table 94 The Multiple Regression Model of Upper Position Arm Reach Length (D_{29}) of Women With Squatting Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Hand Length (S_5)	0.08	0.10	0.82NS
Normal Squatting Height (S_{24})	0.60	0.12	4.90**
Mid Shoulder Height (S_{26})	-0.75	0.13	-5.93**
Right Knee Height (S_{27})	-0.17	0.11	-1.62NS

B_0=58.29 R^2=0.08 F= 10.57**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.6.3.3 Path Analysis Between Squatting Static Anthropometry and Upper Position Arm Reach Length of Women

Path analysis between selected squatting static anthropometry and upper position arm reach length of women in squatting position is presented in Table 95 and Figure 66

It is apparent from Table that the total effect of mid-shoulder height (-0.16) on upper position arm reach length of women in squatting position was negative and significant.

Though the total effect of the normal squatting height (0.03) on upper position arm reach length of women in squatting posture was non significant direct effect was positive (0.31). The direct effect of mid-shoulder height (-0.38) on upper position arm reach length in squatting posture was negative and indirect effect of right knee height on upper position arm reach length was negative and more (-0.11) than its direct effect.

Table 95 Path Analysis Between Squatting Static Anthropometry and Upper Position Arm Reach Length (D_{29}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Hand Length (S_5)	0.01	0.04	-0.03	-0.07(S_{26})	0.04(S_{27})
Normal Squatting Height (S_{24})	0.03	0.31	-0.28	-0.27(S_{26})	-0.01(S_{27})
Mid Shoulder Height (S_{26})	-0.16	-0.38	0.22	0.23(S_{24})	-0.01(S_{27})
Right Knee Height (S_{27})	-0.10	-0.01	-0.11	-0.08(S_{26})	0.04(S_{24})

The effect of mid-shoulder height on upper position arm reach length via normal squatting height of women was positive and maximum.

4.6.4 Relationship Between Squatting Static Anthropometry and Mid Position Arm Reach Length of Women

4.6.4.1 Simple Correlation and Regression Analysis Between Squatting Static Measurements and Mid Position Arm Reach Length of Women

Simple correlation and regression analysis between squatting static anthropometry and mid position arm reach length of women is presented in Table 96 and Figure 67.

It is evident from the Table that the hand length ($r= 0.40^{**}$), normal squatting height ($r=0.20^{**}$), mid-shoulder height($r=0.18^{**}$) and right knee height ($r=0.24^{**}$) were positively correlated with mid position arm reach length of women in squatting posture which indicated that as hand length, normal squatting height, mid-shoulder height and right knee height increase the middle position arm reach length of women in squatting posture increases. Hand length exerted 16 per cent effect on mid position arm reach length of women in squatting posture and meager effect of normal squatting height (4 %), mid-shoulder height (3 %) and right knee height (6 %) was noticed on mid position arm reach length of women in squatting posture.

Table 96 Simple Correlation and Regression Analysis Between Squatting Static Anthropometry and Mid Position Arm Reach Length (D_{30}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Hand Length (S_5)	0.40^{**}	0.16	D_{30}=46.47+0.51 S_5
Normal Squatting Height (S_{24})	0.20^{**}	0.04	D_{30}=61.74+0.23 S_{24}
Mid Shoulder Height (S_{26})	0.18^{**}	0.03	D_{30}=66.95+0.22 S_{26}
Right Knee Height (S_{27})	0.24^{**}	0.06	D_{30}=67.20+0.33 S_{27}

** Significant at 1 per cent level of significance

Regression coefficient indicated 0.51 and 0.23 cm increase in mid position arm reach length of women with an increase of one centimeter in hand length and normal squatting height respectively. The increase of 0.22 cm and 0.33 cm was noticed in mid position arm reach length with an increase of one centimeter in mid-shoulder height and right knee height respectively.

4.6.4.2 The Multiple Regression Model of Mid Position Arm Reach Length of Women With Squatting Static Anthropometry

The multiple regression model of mid position arm reach length of women with squatting static anthropometry is presented in Table 97

It is apparent from the Table that the set of selected anthropometric measurements could explain the variation in mid position arm reach length by only 9 per cent. Hand length ($t=7.66^{**}$), normal squatting height ($t=2.51^{*}$) and right knee height ($t=4.77^{**}$) contributed positively and significantly to mid position arm reach length. Partial regression coefficient indicated 0.43 cm, 0.29 cm and 0.18cm increase in mid position arm reach length with an increase of one centimeter in hand length, right knee height and normal squatting height respectively.

Table 97 The Multiple Regression Model of Mid Position Arm Reach Length (D_{30}) of Women With Squatting Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Hand Length (S_5)	0.43	0.05	7.66^{**}
Normal Squatting Height (S_{24})	0.18	0.07	2.51^{*}
Mid Shoulder Height (S_{26})	0.033	0.07	0.43NS
Right Knee Height (S_{27})	0.29	0.06	4.77^{**}

$B_0= 51.15$ $R^2= 0.09$ $F= 15.81^{**}$

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.6.4.3 Path Analysis Between Squatting Static Anthropometry and Mid Position Arm Reach Length of Women

Path analysis between selected squatting static anthropometry and mid position arm reach length of women is presented in Table 98 and Figure 68.

It is clear from the Table that the total effect of hand length (0.40), normal squatting height (0.20), mid-shoulder height (0.18) and right knee height (0.24) on mid position arm reach length of women in squatting position was positive and significant.

Table 98 Path Analysis Between Squatting Static Anthropometry and Mid Position Arm Reach Length (D_{30}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Hand Length (S_5)	0.40	0.34	0.06	0.03(S_{27})	0.02(S_{24})
Normal Squatting Height (S_{24})	0.20	0.09	0.11	0.08(S_5)	0.02(S_{26})
Mid Shoulder Height (S_{26})	0.18	0.03	0.15	0.07(S_{24})	0.06(S_5)
Right Knee Height (S_{27})	0.24	0.10	0.14	0.12(S_5)	0.01(S_{24})

The direct effect of hand length (0.34) on mid position arm reach length was more than it's indirect effect. The effect of mid-shoulder height (0.15), right knee height (0.14) and normal squatting height (0.11) on middle position arm reach length in squatting posture was indirect and positive. The effect of right knee height on mid position arm reach length via hand length was positive and more (0.12) than other measurements.

Thus, it can be inferred that right knee height and hand length affect the mid position arm reach length of women in squatting posture.

4.6.5 Relationship Between Squatting Static Anthropometry and Lower Position Arm Reach Length of Women

4.6.5.1 Simple Correlation and Regression Analysis Between Squatting Static Measurements and Lower Position Arm Reach Length of Women

Simple correlation and regression analysis between squatting static anthropometry and lower position arm reach length of women is presented in Table 99 and Figure 69.

It is evident from the Table that the hand length ($r=0.41^{**}$), normal squatting height ($r=0.12^{**}$), mid-shoulder height ($r=0.12^{**}$) and right knee height ($r=0.36^{**}$) were positively correlated with lower position arm reach length of women in squatting posture which indicated that as the hand length, normal squatting height, mid-shoulder height and right knee height increases the lower position arm reach length of women in squatting posture also increase.

Table 99 Simple Correlation and Regression Analysis Between Squatting Static Anthropometry and Lower Position Arm Reach Length (D_{31}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Hand Length (S_5)	0.41^{**}	0.17	D_{31}=35.65+0.55 S_5
Normal Squatting Height (S_{24})	0.12^{**}	0.014	D_{31}=61.18+0.15 S_{24}
Mid Shoulder Height (S_{26})	0.12^{**}	0.014	D_{31}=63.91+0.15 S_{26}
Right Knee Height (S_{27})	0.36^{**}	0.13	D_{31}=50.34+0.53 S_{27}

** Significant at 1 per cent level of significance

Values of 'r' square indicated meager effect of hand length (17%), normal squatting height (1 %), mid-shoulder height (1 %) and right knee height (13 %) on lower position arm reach length of women in squatting posture. Regression coefficient indicated 0.55 and 0.53 cm increase in lower position arm reach length of women with an increase of one centimeter in hand length and right knee height of women in squatting posture. An equal increase of 0.45 cm was noticed in lower position arm reach length with an increase of one centimeter in normal squatting height and mid-shoulder height.

4.6.5.2 The Multiple Regression Model of Lower Position Arm Reach Length of Women With Squatting Static Anthropometry

The multiple regression model of lower position arm reach length of women with squatting static anthropometry is reported in Table 100

It is perceptible from the Table that the set of selected anthropometric measurements could explain the variation in lower position arm reach length by only 22 per cent. Hand length ($t=7.52^{**}$), right knee height ($t=5.81^{**}$) contributed positively and significantly to lower position arm reach length of women in squatting posture.

Table 100 The Multiple Regression Model of Lower Position Arm Reach Length (D_{31}) of Women With Squatting Static Anthropometry

Anthropometric Variables	**Partial Regression Coefficient (b_i)**	**SE (b_i)**	**t (b_i)**
Hand Length (S_5)	0.43	0.06	7.52^{**}
Normal Squatting height (S_{24})	0.03	0.07	0.52NS
Mid Shoulder Height (S_{26})	-0.023	0.073	-0.32NS
Right Knee Height (S_{27})	0.37	0.063	5.81^{**}

$B_0=26.08$ $R^2=0.22$ $F= 35.95^{**}$

** Significant at 1% level of significance NS Non significant

Partial regression coefficient indicated 0.43 and 0.37 cm increase in lower position arm reach length with an increase of one centimeter in hand length and right knee height respectively.

4.6.5.3 Path Analysis Between Squatting Static Anthropometry and Lower Position Arm Reach Length of Women

Path analysis between selected squatting static anthropometry and lower position arm reach length of women in squatting position is presented in Table 101 and Figure 70

It is apparent from the Table that the total effect of hand length (0.41) and right knee height (0.36) was more on lower position arm reach length of women in squatting position followed by equal effect of normal squatting height

(0.12) and mid-shoulder height (0.12). The direct effect of hand length (0.32) and right knee height (0.25) was more on lower position arm reach length of women. Substantial indirect effect of selected squatting static anthropometry was meager on lower position arm reach length of women in squatting posture.

Table 101 Path Analysis Between Squatting Static Anthropometry and Lower Position Arm Reach Length (D_{31}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Hand Length (S_5)	0.41	0.32	0.09	0.08(S_{27})	0.007(S_{24})
Normal Squatting Height (S_{24})	0.12	0.03	0.09	0.07(S_5)	0.03(S_{27})
Mid Shoulder Height (S_{26})	0.12	-0.02	0.14	0.06(S_5)	0.03(S_{27})
Right Knee Height (S_{27})	0.36	0.25	0.11	0.11(S_5)	0.004(S_{24})

Thus, it can be inferred that the only hand length and right knee height revealed effect through total and direct effect on lower position arm reach length of women in squatting posture.

4.6.6 Relationship Between Squatting Static Anthropometry and Upper Position Arm Reach Height of Women

4.6.6.1 Simple Correlation and Regression Analysis Between Squatting Static Measurements and Upper Position Arm Reach Height of Women

Simple correlation and regression analysis between squatting static anthropometry and upper position arm reach height of women is presented in Table 102 and Figure 71.

It is evident from the Table that the hand length ($r=0.23^{**}$), normal squatting height ($r=0.36^{**}$), mid-shoulder height($r=0.32^{**}$) and right knee height

($r=0.10^{*}$) were positively correlated with upper position arm reach height of women in squatting posture which indicates that as the hand length, normal squatting height, mid-shoulder height and right knee height increase the upper position arm reach height of women in squatting posture increases. Values of 'r' square indicated meager effect of hand length (5%), normal squatting height (13 %), mid-shoulder height (10 %) and right knee height (1 %) on upper position arm reach height of women in squatting posture.

Regression coefficient indicated 0.27cm and 0.37 cm increase in upper position arm reach height of women with an increase of one centimeter in hand length and normal squatting height respectively. The increase of 0.35 cm and 0.13 cm was noticed in upper position arm reach height with an increase of one centimeter in mid-shoulder height and right knee height respectively.

Table 102 Simple Correlation and Regression Analysis Between Squatting Static Anthropometry and Upper Position Arm Reach Height (D_{32}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Hand Length (S_5)	0.23^{**}	0.05	$D_{32}=85.62+0.27\ S_5$
Normal Squatting Height (S_{24})	0.36^{**}	.0.13	$D_{32}=71.93+0.37\ S_{24}$
Mid Shoulder Height (S_{26})	0.32^{**}	0.10	$D_{32}=80.83+0.35\ S_{26}$
Right Knee Height (S_{27})	0.10^{*}	0.01	$D_{32}= 98.48+0.13\ S_{27}$

** Significant at 1% level of significance * Significant at 5 per cent level of significance

4.6.6.2 The Multiple Regression Model of Upper Position Arm Reach Height of Women With Squatting Static Anthropometry

The multiple regression model of upper position arm reach height of women with squatting static anthropometry is reported in Table 103

It is evident from the Table that the set of selected anthropometric measurements could explain the variation in upper position arm reach height by only 16 per cent. Hand length ($t=3.48^{**}$) and normal squatting height ($t=4.59^{**}$) contributed positively and significantly to upper position arm reach height of women in squatting posture. Partial regression coefficient indicated 0.18 cm and 0.29 cm increase in upper position arm reach height with an increase of one centimeter in hand length and normal squatting height respectively.

Table 103 The Multiple Regression Model of Upper Position Arm Reach Height (D_{32}) of women with squatting static anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Hand Length (S_5)	0.18	0.052	3.48^{**}
Normal Squatting Height (S_{24})	0.29	0.063	4.59^{**}
Mid Shoulder Height (S_{26})	0.11	0.067	1.72NS
Right Knee Height (S_{27})	0.055	0.054	1.00NS

$B_0=61.92$ $R^2=0.16$ $F= 23.53^{**}$

** Significant at 1% level of significance NS Non significant

4.6.6.3 Path Analysis Between Squatting Static Anthropometry and Upper Position Arm Reach Height of Women

Path analysis between selected squatting static anthropometry and upper position arm reach height of women in squatting position is presented in Table 104 and Figure 72.

It is obvious from the Table that the total effect of normal squatting height (0.36) and mid-shoulder height (0.32) was more followed by the total effect of hand length (0.23) and right knee height (0.10) on upper position arm reach height in squatting posture. The direct effect of normal squatting height (0.25) and hand length (0.15) on upper position arm reach height of women was positive and more while the indirect effect of mid-shoulder height and normal squatting height on upper position arm reach height in squatting posture was more than the direct effect.

Substantial indirect effect of mid-shoulder height on upper position arm reach height in squatting posture was noticed through normal squatting height (0.18). The substantial indirect effect of hand length, normal squatting height and right knee height was very meager on upper position arm reach height of women in squatting posture.

Table 104 Path Analysis Between Squatting Static Anthropometry and Upper Position Arm Reach Height (D_{32}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Hand Length (S_5)	0.23	0.15	0.08	0.06(S_{24})	0.02(S_{26})
Normal Squatting Height (S_{24})	0.36	0.25	0.11	0.08(S_{26})	0.03(S_5)
Mid Shoulder Height (S_{26})	0.32	0.10	0.22	0.18(S_{24})	0.03(S_5)
Right Knee Height (S_{27})	0.10	-0.01	0.11	0.05(S_5)	0.03(S_{24})

It is concluded that normal squatting height cause direct and indirect changes in upper position arm reach height of women in squatting posture.

4.6.7 Relationship Between Squatting Static Anthropometry and Mid Position Arm Reach Height of Women

4.6.7.1 Simple Correlation and Regression Analysis Between Squatting Static Measurements and Mid Position Arm Reach Height of Women

Simple correlation and regression analysis between squatting static anthropometry and mid position arm reach height of women is presented in Table 105 and Figure 73.

It is evident from the Table that the hand length ($r=0.18^{**}$), normal squatting height ($r=0.44^{**}$) and mid-shoulder height($r=0.30^{**}$) were positively correlated with mid position arm reach height of women in squatting posture which indicated that as the hand length, normal squatting height and mid-shoulder height increase the middle position arm reach height of women in squatting posture increases.

Table 105 Simple Correlation and Regression Analysis Between Squatting Static Anthropometry and Mid Position Arm Reach Height (D_{33}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Hand Length (S_5)	0.18^{**}	0.03	$D_{33}=50.64+0.18\ S_5$
Normal Squatting Height (S_{24})	0.44^{**}	0.19	$D_{33}=29.32+0.39\ S_{24}$
Mid Shoulder Height (S_{26})	0.30^{**}	0.09	$D_{33}=44.47+0.28\ S_{26}$
Right Knee Height (S_{27})	0.04NS	0.001	$D_{33}=61.35+0.05\ S_{27}$

** Significant at 1 per cent level of significance NS Non significant

Values of 'r' square indicated meager effect of hand length (3%), normal squatting height (19 %) and mid-shoulder height (9 %) on middle position arm reach height of women in squatting posture. Regression coefficient indicated 0.39 cm and 0.28cm increase in mid position arm reach height of women with an increase of one centimeter in normal squatting height and mid-shoulder height of women. The increase of 0.18 cm was noticed in mid position arm reach height with an increase of one centimeter in hand length of women.

4.6.7.2 The Multiple Regression Model of Mid Position Arm Reach Height of Women With Squatting Static Anthropometry

The multiple regression model of mid position arm reach height of women with squatting static anthropometry is reported in Table 106

It is noticeable from the Table that the set of selected anthropometric measurements could explain the variation in mid position arm reach height by only 20 per cent. Hand length ($t=2.39^{*}$) and normal squatting height ($t=7.78^{**}$) contributed positively and significantly to middle position arm reach height of women. Partial regression coefficient indicated 0.41 cm and 0.10 cm increase in mid position arm reach height with an increase of one centimeter in normal squatting height and hand length respectively.

Table 106 The Multiple Regression Model of Mid Position Arm Reach Height (D_{33}) of Women With Squatting Static Anthropometry

Anthropometric Variables	**Partial Regression Coefficient (b_i)**	**SE (b_i)**	**t (b_i)**
Hand Length (S_5)	0.10	0.04	2.39^{*}
Normal Squatting Height (S_{24})	0.41	0.05	7.78^{**}
Mid Shoulder Height (S_{26})	-0.04	0.05	-0.81NS
Right Knee Height (S_{27})	-0.05	0.04	-1.05NS

$B_0= 26.04$ $R^2= 0.20$ $F=32.08^{**}$

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.6.7.3 Path Analysis Between Squatting Static Anthropometry and Mid Position Arm Reach Height of Women

Path analysis between selected squatting static anthropometry and mid position arm reach height of women is presented in Table 107 and Figure 74.

It is clear from the Table that the total effect of normal squatting height (0.44), mid-shoulder height (0.30) and hand length (0.18) on mid position arm reach height in squatting posture was significant and positive. The direct effect of normal squatting height (0.46) on upper position arm reach height of women was positive and more while the effect of mid-shoulder height (0.35) on middle position arm reach height in squatting posture was indirect and positive.

Substantial indirect effect of mid-shoulder height on mid position arm reach height in squatting posture was noticed through normal squatting height (0.33). The substantial indirect effect of hand length, normal squatting height and right knee height was very meager on mid position arm reach height of women in squatting posture.

Table 107 Path Analysis Between Squatting Static Anthropometry and Mid Position Arm Reach Height (D_{33}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Hand Length (S_5)	0.18	0.10	0.08	0.10(S_{24})	-0.01(S_{27})
Normal Squatting Height (S_{24})	0.44	0.46	-0.02	-0.03(S_{26})	0.02(S_5)
Mid Shoulder Height (S_{26})	0.30	-0.05	0.35	0.33(S_{24})	0.02(S_5)
Right Knee Height (S_{27})	0.04	-0.04	0.05	0.06(S_{24})	0.03(S_5)

It is concluded that normal squatting height cause direct and indirect changes in mid position arm reach height of women in squatting posture.

4.6.8 Relationship Between Squatting Static Anthropometry and Upper Position Grasp Reach Length of Women

4.6.8.1 Simple Correlation and Regression Analysis Between Squatting Static Measurements and Upper Position Grasp Reach Length of women

Simple correlation and regression analysis between squatting static anthropometry and upper position grasp reach length of women is presented in Table 108 and Figure 75.

It is apparent from the Table that the mid-shoulder height ($r=-0.13^{**}$) was negatively correlated with upper position grasp reach length of women in squatting posture which indicated that as the mid-shoulder height increases the upper position grasp reach length of women in squatting posture decreases. Value of 'r' square indicated meager effect of mid-shoulder height ($r^2=0.017$) on middle position grasp reach length of women in squatting posture. Regression coefficient showed 0.24 cm decrease in upper position grasp reach length of women with an increase of one centimeter in mid-shoulder height. The normal squatting height and right knee height was not found to be correlated with upper position grasp reach length of women in squatting posture.

Table 108 Simple Correlation and Regression Analysis Between Squatting Static Anthropometry and Upper Position Grasp Reach Length (D_{34}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Hand Length (S_5)	0.02NS	0.0004	D_{34}=49.8+0.03 S_5
Normal Squatting Height (S_{24})	0.05NS	0.002	D_{34}=43.44+0.1 S_{24}
Mid Shoulder Height (S_{26})	-0.13^{**}	0.017	D_{34}=68.27-0.24 S_{26}
Right Knee Height (S_{27})	-0.07NS	0.005	D_{34}=59.08-0.16 S_{27}

** Significant at 1% level of significance NS Non significant

4.6.8.2 The Multiple Regression Model of Upper Position Grasp Reach Length of Women With Squatting Static Anthropometry

The multiple regression model of upper position grasp reach length of women with squatting static anthropometry is noted in Table 109

It is obtrusive from the Table that the set of selected anthropometric measurements could explain the variation in upper position grasp reach length by only seven per cent. Normal squatting height ($t=4.87^{**}$) contributed positively and significantly to upper position grasp reach length. Where as mid-shoulder height ($t=-5.47^{**}$) contributed negatively and significantly to upper position grasp reach length of women in squatting posture. Partial regression coefficient indicated 0.55 cm increase in upper position grasp reach length with an increase of one centimeter in normal squatting height and 0.65 cm decrease in upper position grasp reach length with an increase of one centimeter in mid-shoulder height.

Table 109 The Multiple Regression Model of Upper Position Grasp Reach Length (D_{34}) of Women With Squatting Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Hand Length (S_5)	0.06	0.09	0.71NS
Normal Squatting height (S_{24})	0.55	0.11	4.87^{**}
Mid Shoulder Height (S_{26})	-0.65	0.12	-5.47^{**}
Right Knee Height (S_{27})	-0.12	0.1	-1.14NS

$B_0= 51.99$ $R^2= 0.07$ F= 11.70*

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.6.8.3 Path Analysis Between Squatting Static Anthropometry and Upper Position Grasp Reach Length of Women

Path analysis between selected squatting static anthropometry and upper position grasp reach length of women in squatting position is presented in Table 110 and Figure 76.

It is apparent from Table that the total effect of mid-shoulder height (-0.13) on upper position grasp reach length of women in squatting position was negative and significant. Though the total effect of the normal squatting height (0.05) on upper position grasp reach length of women in squatting posture was non significant, direct effect was positive (0.31). The direct effect of mid-shoulder height (-0.35) on upper position grasp reach length in squatting posture was negative and indirect effect (0.22) was positive. The effect of mid-shoulder height on upper position grasp reach length via normal squatting height was positive and maximum (0.23). While the substantial indirect effect of normal squatting height via mid-shoulder height (-0.25) was negative.

Table 110 Path Analysis Between Squatting Static Anthropometry and Upper Position Grasp Reach Length (D_{34}) of Women

Anthropometric Variables	**Total Effect**	**Direct Effect**	**Indirect Effect**	**Substantial Indirect Effect (I)**	**Substantial Indirect Effect (II)**
Hand Length (S_5)	0.01	0.03	-0.02	0.07 (S_{24})	-0.07(S_{26})
Normal Squatting Height (S_{24})	0.05	0.31	-0.26	-0.25(S_{26})	-0.007(S_5)
Mid Shoulder Height (S_{26})	-0.13	-0.35	0.22	0.23(S_{24})	-0.01(S_{27})
Right Knee Height (S_{27})	-0.07	-0.05	-0.02	-0.07(S_{26})	0.04(S_{24})

It can be concluded that normal squatting height and mid-shoulder height contributes to the upper position grasp reach length of women in squatting posture.

4.6.9 Relationship between squatting static anthropometry and Mid Position Grasp Reach Length of women

4.6.9.1 Simple Correlation and Regression Analysis between squatting static measurements and Mid Position Grasp Reach Length of women

Simple Correlation and Regression Analysis between squatting static anthropometry and mid position grasp reach length of women is presented in Table 111 and Figure 77.

It is evident from the Table that the hand length ($r=0.40^{**}$), normal squatting height ($r=0.17^{**}$), mid-shoulder height($r=0.13^{**}$) and right knee height ($r=0.20^{**}$) were positively correlated with mid position grasp reach length of women in squatting posture which indicated that as the hand length, normal squatting height, mid-shoulder height and right knee height increase the mid position grasp reach length of women in squatting posture increases.

Table 111 Simple Correlation and Regression Analysis Between Squatting Static Anthropometry and Mid Position Grasp Reach Length (D_{35}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Hand Length (S_5)	0.40^{**}	0.16	D_{35}=38.64+0.53 S_5
Normal Squatting Height (S_{24})	0.17^{**}	0.03	D_{35}=58.33+0.2 S_{24}
Mid Shoulder Height (S_{26})	0.13^{**}	0.017	D_{35}=64.64+0.16S_{26}
Right Knee Height (S_{27})	0.20^{**}	0.04	D_{35}=62.29+0.3 S_{27}

** Significant at 1 per cent level of significance

Values of 'r' square indicated meager effect of hand length (16%), normal squatting height (3 %), mid-shoulder height (2 %) and right knee height (4 %) on mid position grasp reach length of women in squatting posture. Regression coefficient indicated 0.53 and 0.2 cm increase in mid position grasp reach length of women with an increase of one centimeter in hand length and normal squatting height respectively. An increase of 0.16 cm and 0.3 cm was noticed in mid position grasp reach length with an increase of one centimeter in mid-shoulder height and right knee height respectively.

4.6.9.2 The Multiple Regression Model of Mid Position Grasp Reach Length of Women With Squatting Static Anthropometry

The multiple regression model of mid position grasp reach length of women with squatting static anthropometry is noted in Table 112

It is perceptible from the Table that the set of selected anthropometric measurements could explain the variation in mid position grasp reach length by only 17 per cent. Hand length ($t=8.16^{**}$), normal squatting height ($t=2.60^{*}$) and right knee height ($t=4.26^{**}$) contributed positively and significantly to mid position grasp reach length of women in squatting posture.

Table 112 The Multiple Regression Model of Mid Position Grasp Reach Length (D_{35}) of Women With Squatting Static Anthropometry

Anthropometric Variables	**Partial Regression Coefficient (b_i)**	**SE (b_i)**	**t (b_i)**
Hand Length (S_5)	0.47	0.06	8.16^{**}
Normal Squatting Height (S_{24})	0.19	0.07	2.60^{*}
Mid Shoulder Height (S_{26})	-0.035	0.08	-0.45NS
Right Knee Height (S_{27})	0.27	0.06	4.26^{**}

$B_0=$ 30.26 $R^2= 0.17$ $F= 26.16^{**}$

** Significant at 1% level of significance * Significant at 5% level of significance

NS Non significant

Partial regression coefficient indicated an increase of 0.47,0.19 and 0.27 cm in mid position grasp reach length with one centimeter increase in hand length, normal squatting height and right knee height respectively

4.6.9.3 Path Analysis Between Squatting Static Anthropometry and Mid Position Grasp Reach Length of Women

Path analysis between selected squatting static anthropometry and mid position grasp reach length of women is presented in Table 113 and Figure 78.

It is evident from the Table that the total effect of hand length (0.40), normal squatting height (0.17), mid-shoulder height (0.13) and right knee height (0.20) on mid position grasp reach length of women in squatting position was positive and significant.

The direct effect of hand length (0.36) on mid position grasp reach length of women was more and positive. The effect of mid-shoulder height (0.16) on mid position grasp reach length in squatting posture was indirect and positive.

Table 113 Path Analysis Between Squatting Static Anthropometry and Mid Position Grasp Reach Length (D_{35}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Hand Length (S_5)	0.40	0.36	0.04	0.02(S_{27})	0.02(S_{24})
Normal Squatting height (S_{24})	0.17	0.09	0.08	0.08(S_5)	-0.02(S_{26})
Mid Shoulder Height (S_{26})	0.13	-0.03	0.16	0.07(S_5)	0.07(S_{24})
Right Knee Height (S_{27})	0.20	0.07	0.01	0.12(S_5)	0.01(S_{24})

The substantial indirect effect of right knee height on mid position grasp reach length via hand length was positive and more (0.12) as compared to other squatting static measurements.

Thus, it can be inferred that right knee height and hand length affect the mid position grasp reach length of women in squatting posture.

4.6.10 Relationship Between Squatting Static Anthropometry and Lower Position Grasp Reach Length of Women

4.6.10.1 Simple Correlation and Regression Analysis Between Squatting Static Measurements and Lower Position Grasp Reach Length of Women

Simple correlation and regression analysis between squatting static anthropometry and lower position grasp reach length of women is presented in Table 114 and Figure 79.

It is evident from the Table that the hand length ($r=0.41^{**}$), normal squatting height ($r=0.10^{*}$), mid-shoulder height ($r=0.11^{*}$) and right knee height ($r=0.39^{**}$) were positively correlated with lower position grasp reach length of women in squatting posture which indicated that as the hand length, normal squatting height, mid-shoulder height and right knee height increase the lower position grasp reach length of women in squatting posture increases.

Table 114 Simple Correlation and Regression Analysis Between Squatting Static Anthropometry and Lower Position Grasp Reach Length (D_{36}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Hand Length (S_5)	0.41^{**}	0.17	D_{36}=31.46+0.54 S_5
Normal Squatting Height (S_{24})	0.10^{*}	0.01	D_{36}=58.71+0.12 S_{24}
Mid Shoulder Height (S_{26})	0.11^{*}	0.012	D_{36}=59.34+0.14 S_{26}
Right Knee Height (S_{27})	0.39^{**}	0.152	D_{36}=43.72+0.57 S_{27}

** Significant at 1 per cent level of significance * Significant at 5 per cent level of significance

Values of 'r' square indicated meager effect of hand length (17%), normal squatting height (1 %), mid-shoulder height (1 %) and right knee height (15 %) on lower position grasp reach length of women in squatting posture. Regression coefficient indicated 0.54cm and 0.12 cm increase in lower position grasp reach length of women with an increase of one centimeter in hand length and normal squatting height respectively. An increase of 0.14 cm was noticed with an increase of one centimeter of mid-shoulder height of women in squatting posture. The increase of 0.57 cm was noticed in lower position grasp reach length with an increase of one centimeter in right knee height.

4.6.10.2 The Multiple Regression Model of Lower Position Grasp Reach Length of Women With Squatting Static Anthropometry

The multiple regression model of lower position grasp reach length of women with squatting static anthropometry is reported in Table 115

It is visible from the Table that the set of selected anthropometric measurements could explain the variation in lower position grasp reach length by 24 per cent. Hand length (t=7.36**), right knee height (t=6.65**) contributed positively and significantly to lower position grasp reach length of women in squatting posture.

Table 115 The Multiple Regression Model of Lower Position Grasp Reach Length (D_{36}) of Women With Squatting Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Hand Length (S_5)	0.41	0.05	7.36**
Normal Squatting Height (S_{24})	-0.01	0.07	-0.19NS
Mid Shoulder Height (S_{26})	-0.001	0.07	0.01NS
Right Knee Height (S_{27})	0.41	0.06	6.65**

B_0=22.99 R^2= 0.24 F= 38.62**

** Significant at 1% level of significance NS Non significant

Partial regression coefficient indicated equal increase of 0.41cm in lower position grasp reach length with an increase of one centimeter in hand length and right knee height.

4.6.10.3 Path Analysis Between Squatting Static Anthropometry and Lower Position Grasp Reach Length of Women

Path analysis between selected squatting static anthropometry and lower position arm reach length of women in squatting position is presented in Table 116 and Figure 80.

It is apparent from Table that the total effect of hand length (0.41), normal squatting height (0.10), mid-shoulder height (0.11) and right knee height (0.39) on lower position grasp reach length of women in squatting position was positive and significant.

Table 116 Path Analysis Between Squatting Static Anthropometry and Lower Position Grasp Reach Length (D_{36}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Hand Length (S_5)	0.41	0.31	0.10	0.1(S_{27})	-0.002(S_{24})
Normal Squatting height (S_{24})	0.10	-0.01	0.11	0.07(S_5)	0.04(S_{27})
Mid Shoulder Height (S_{26})	0.11	0.001	0.109	0.06(S_5)	0.06(S_{27})
Right Knee Height (S_{27})	0.39	0.28	0.11	0.11(S_5)	-0.001(S_{24})

Hand length (0.31) showed maximum direct effect on lower position arm reach length of women in squatting position followed by the direct effect of right knee height (0.28). The substantial indirect effect of right knee height on lower position grasp reach length of women was very meager through hand length (0.11).

Thus, it can be inferred that the right knee height denoted effect through total and indirect effect on lower position grasp reach length of women in squatting posture.

4.6.11 Relationship Between Squatting Static Anthropometry and Upper Position Grasp Reach Height of Women

4.6.11.1 Simple Correlation and Regression Analysis Between Squatting Static Measurements and Upper Position Grasp Reach Height of Women

Simple correlation and regression analysis between squatting static anthropometry and upper position grasp reach height of women is presented in Table 117 and Figure 81.

It is evident from the Table that the hand length ($r=0.24^{**}$), normal squatting height ($r=0.34^{**}$), mid-shoulder height($r=0.32^{**}$) and right knee height ($r=0.10^{*}$) were positively correlated with upper position grasp reach height of women in squatting posture which indicated that as the hand length, normal squatting height, mid-shoulder height and right knee height increase the upper position grasp reach height of women in squatting posture increases.

Table 117 Simple Correlation and Regression Analysis Between Squatting Static Anthropometry and Upper Position Grasp Reach Height (D_{37}) of Women

Anthropometric Variables	**Correlation Coefficient (r)**	**Coefficient of Determination (r^2)**	**Regression Equation ($\hat{Y}$= a+bx)**
Hand Length (S_5)	0.24^{**}	0.06	$D_{37}=81.6+0.27\ S_5$
Normal Squatting Height (S_{24})	0.34^{**}	0.115	$D_{37}=69.81+0.36\ S_{24}$
Mid shoulder Height (S_{26})	0.32^{**}	0.102	$D_{37}=77.05+0.35\ S_{26}$
Right Knee Height (S_{27})	0.10^{*}	0.01	$D_{37}=94.70+0.13\ S_{27}$

** Significant at 1 per cent level of significance * Significant at 5 per cent level of significance

Values of 'r' square indicated meager effect of hand length (6%), normal squatting height (11%), mid-shoulder height (10%) and right knee height (1%) on upper position grasp reach height of women in squatting posture. Regression coefficient indicated 0.27cm and 0.36 cm increase in upper position grasp reach height of women with an increase of one centimeter in hand length and normal squatting height respectively. The increase of 0.35 cm and 0.13 cm was noticed in upper position grasp reach height with an increase of one centimeter in mid-shoulder height and right knee height respectively.

4.6.11.2 The Multiple Regression Model of Upper Position Grasp Reach Height of Women With Squatting Static Anthropometry

The multiple regression model of upper position grasp reach height of women with squatting static anthropometry is reported in Table 118

It is apparent from the Table that the set of selected anthropometric measurements could explain the variation in upper position grasp reach height by only 15 per cent. Hand length ($t=3.67^{**}$), normal squatting height ($t=3.96^{**}$) and mid-shoulder height ($t=2.19^{*}$) contributed positively and significantly to upper position grasp reach height.

Table 118 The Multiple Regression Model of Upper Position Grasp Reach Height (D_{37}) of women with squatting static anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Hand Length (S_5)	0.19	0.05	3.67^{**}
Normal Squatting Height (S_{24})	0.25	0.063	3.96^{**}
Mid Shoulder Height (S_{26})	0.15	0.067	2.19^{*}
Right Knee Height (S_{27})	0.054	0.054	0.99NS

$B_0=59.26$ $R^2= 0.15$ $F=22.63^{**}$

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

Partial regression coefficient indicated 0.19cm, 0.25 cm and 0.15 cm increase in upper position grasp reach height of women with an increase of one centimeter in hand length, normal squatting height and mid-shoulder height respectively.

4.6.11.3 Path Analysis Between Squatting Static Anthropometry and Upper Position Grasp Reach Height of Women

Path analysis between selected squatting static anthropometry and upper position grasp reach height of women in squatting position is presented in Table 119 and Figure 82.

It is obvious from the Table that the total effect of hand length (0.24), normal squatting height (0.34), mid-shoulder height (0.32) and right knee height (0.10) on upper position grasp reach height in squatting posture was significant and positive. The direct effect of normal squatting height (0.21) on upper position grasp reach height of women was positive and more followed by the direct effect of hand length (0.10). While the indirect effect of mid-shoulder height (0.19) on upper position grasp reach height in squatting posture was more than it's direct effect.

Table 119 Path Analysis Between Squatting Static Anthropometry and Upper Position Grasp Reach Height (D_{37}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Hand Length (S_5)	0.24	0.16	0.08	0.05(S_{24})	0.03(S_{26})
Normal Squatting Height (S_{24})	0.34	0.21	0.13	0.10(S_{26})	0.04(S_5)
Mid Shoulder Height (S_{26})	0.32	0.13	0.19	0.15(S_{24})	0.03(S_5)
Right Knee Height (S_{27})	0.10	-0.01	0.11	0.06(S_5)	0.03(S_{24})

Substantial indirect effect of mid-shoulder height (0.15) on upper position grasp reach height in squatting posture was noticed through normal squatting height. The substantial indirect effect of normal squatting height through mid-shoulder height (0.10) was less on upper position arm reach height of women in squatting posture.

It is concluded that mid-shoulder height and normal squatting height cause direct and indirect changes in upper position grasp reach height of women in squatting posture.

4.6.12 Relationship Between Squatting Static Anthropometry and Mid Position Grasp Reach Height of Women

4.6.12.1 Simple Correlation and Regression Analysis Between Squatting Static Measurements and Mid Position Grasp Reach Height of women

Simple correlation and regression analysis between squatting static anthropometry and mid position grasp reach height of women is presented in Table 120 and Figure 83.

It is evident from the Table that the hand length ($r=0.18^{**}$), normal squatting height ($r=0.43^{**}$) and mid-shoulder height ($r=0.30^{**}$) were positively correlated with mid position grasp reach height of women in squatting posture which indicated that as the hand length, normal squatting height and mid-shoulder height increase the mid position grasp reach height of women in squatting posture increases. Values of 'r' square indicated meager effect of hand length (3%), normal squatting height (18%) and, mid-shoulder height (9%) on mid position grasp reach height of women in squatting posture.

Table 120 Correlation and Regression Analysis Between Squatting Static Anthropometry and Mid Position Grasp Reach Height (D_{38}) of Women

Anthropometric Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Regression Equation ($\hat{Y}$= a+bx)
Hand Length (S_5)	0.18	0.03	D_{38}=46.99+0.18 S_5
Normal Squatting Height (S_{24})	0.43^{**}	0.185	D_{38}=26.12+0.39 S_{24}
Mid Shoulder Height (S_{26})	0.30^{**}	0.09	D_{38}=40.62+0.28 S_{26}
Right Knee Height (S_{27})	0.03NS	0.001	D_{38}=58.03+0.04 S_{27}

** Significant at 1 per cent level of significance NS Non significant

Regression coefficient indicated 0.18 cm and 0.39 cm increase in mid position grasp reach height of women with an increase of one centimeter in hand length and normal squatting height of women in squatting posture respectively. The increase of 0.28 cm was noticed in mid position grasp reach height with an increase of one centimeter in mid-shoulder height.

4.6.12.2 The Multiple Regression Model of Mid Position Grasp Reach Height of Women With Squatting Static Anthropometry

The multiple regression model of mid position grasp reach height of women with squatting static anthropometry is reported in Table 121

It is visible from the Table that the set of selected anthropometric measurements could explain the variation in mid position grasp reach height by only 20 per cent. Hand length ($t=2.46^{*}$), normal squatting height ($t=7.45^{**}$) contributed positively and significantly to mid position grasp reach height. Partial regression coefficient indicated 0.11 and 0.39 cm increase in mid position grasp reach height with an increase of one centimeter in hand length and normal squatting height respectively.

Table 121 The Multiple Regression Model of Middle Position Grasp Reach Height (D_{38}) of Women With Squatting Static Anthropometry

Anthropometric Variables	Partial Regression Coefficient (b_i)	SE (b_i)	t (b_i)
Hand Length (S_5)	0.11	0.04	2.46*
Normal Squatting Height (S_{24})	0.39	0.053	7.45**
Mid Shoulder Height (S_{26})	-0.03	0.056	-0.53NS
Right Knee Height (S_{27})	-0.06	0.048	-1.32NS

B_0= 22.99 R^2=0.20 F=30.98**

** Significant at 1% level of significance * Significant at 5% level of significance
NS Non significant

4.6.12.3 Path analysis between squatting static anthropometry and Mid Position Grasp Reach Height of women

Path analysis between selected squatting static anthropometry and mid position grasp reach height of women is presented in Table 122 and Figure 84.

It is clear from Table that the total effect of hand length (0.18), normal squatting height (0.43), and mid-shoulder height (0.30) on mid position grasp reach height in squatting posture was significant and positive. The direct effect of normal squatting height (0.44) on upper position grasp reach height of women was positive and more while the effect of mid-shoulder height (0.33) on mid position grasp reach height in squatting posture was indirect and positive.

Substantial indirect effect of mid-shoulder height on mid position grasp reach height in squatting posture was noticed through normal squatting height (0.32). The substantial indirect effect of hand length (0.10), normal squatting height

(0.02) and right knee height (0.06) was very meager on middle position grasp reach height of women in squatting posture.

Table 122 Path Analysis Between Squatting Static Anthropometry and Mid Position Grasp Reach Height (D_{38}) of Women

Anthropometric Variables	Total Effect	Direct Effect	Indirect Effect	Substantial Indirect Effect (I)	Substantial Indirect Effect (II)
Hand Length (S_5)	0.18	0.12	0.06	0.10(S_{24})	-0.01(S_{27})
Normal Squatting Height (S_{24})	0.43	0.44	-0.1	0.02(S_5)	-0.02(S_{26})
Mid Shoulder Height (S_{26})	0.30	-0.03	0.33	0.32(S_{24})	0.02(S_5)
Right Knee Height (S_{27})	0.03	-0.05	0.08	0.06(S_{24})	0.04(S_5)

It is concluded that mid-shoulder height via normal squatting height cause changes in mid position grasp reach height of women in squatting posture.

On the whole it was noticed that among the vertical squatting dynamic measurements the effect of squatting static anthropometry was noticed to be more only on vertical arm reach (58%) followed by vertical grasp reach of women (30%). Normal squatting height, hand length and mid-shoulder height contributed more in deciding squatting dynamic anthropometry of women.

4.7 Statistical Models For Relationship Between Static and Dynamic Anthropometry of Women

4.7.1 Statistical Models For Relationship Between Standing Static and Vertical Dynamic Anthropometry of Women

Statistical models explaining the relationship between selected static and vertical dynamic anthropometry of women in standing position is presented in Table 123.

It is clear from the Table that the linear multiple regression models were better fit and has shown highly significant values for coefficient of multiple determinations for selected vertical dynamic anthropometry of women except for forward lower position reach height of women in standing position. Coefficient of multiple determination explained more than 50 per cent of the variation in vertical upward arm reach (R^2= 0.83), vertical upward grasp reach (R^2= 0.79), upper position height (R^2= 0.68), middle position height (R^2= 0.58), upper position grasp reach height (R^2= 0.63) and forward upper position reach height (R^2= 0.53) due to selected set of static anthropometry. The selected set of static anthropometry caused a variation of 30 to 45 per cent in middle position grasp reach height (R^2= 0.31), forward middle position reach height (R^2= 0.31) and forward upper position grasp reach height (R^2= 0.30).

It is clear from the Table that all the selected static anthropometric measurements except mid-shoulder height influence the vertical dynamic anthropometry of women in standing position.

Table 123 Statistical Models For Assessing Vertical Dynamic Anthropometry of Women in Standing Position.

Dynamic Anthropometry	**Statistical Model** $\hat{Y} = b_0+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6$	**Coefficient of Multiple Determination (R^2)**	**F Value**
Vertical Upward Arm Reach From Floor (D_1)	$D_1=2.07 + 0.59S_1^{**} - 0.002S_4 + 0.19S_5^{**} + 0.07S_8 + 0.17S_{10}^{**} + 0.43S_{14}^{**}$	0.83	412.61^{**}
Vertical Upward Grasp Reach (D_2)	$D_2=7.18 + 0.65S_1^{**} + 0.001S_4 + 0.14S_5^{*} + 0.02S_8 + 0.12S_{10}^{*} + 0.36S_{14}^{**}$	0.79	315.28^{**}
Upper Position Height (D_6)	$D_6=12.52 + 0.38S_1^{**} - 0.08S_4 + 0.31S_5^{**} + 0.13S_8^{*} + 0.49S_{10}^{**} + 0.29S_{14}^{**}$	0.68	175.71^{**}
Middle Position Height (D_7)	$D_7=30.34 + 0.28S_1^{**} + 0.02S_4 + 0.005S_5 + 0.12S_8^{**} + 0.2S_{10}^{**} + 0.14S_{14}^{**}$	0.58	113.41^{**}
Lower Position Height (D_8)	$D_8=17.41 + 0.61S_1^{**} + 0.11S_4 - 0.36S_5^{**} - 0.13S_8^{*} - 0.17S_{10}^{*} + 0.02S_{14}$	0.17	16.79^{**}
Upper Position Grasp Reach Height (D_9)	$D_9=10.07 + 0.29S_1^{**} - 0.11S_4 + 0.32S_5^{**} + 0.21S_8^{**} + 0.55S_{10}^{**} + 0.27S_{14}^{**}$	0.63	137.84^{**}
Middle Position Grasp Reach Height (D_{10})	$D_{10}=40.36 + 0.17S_1 + 0.005S_4 - 0.02S_5 + 0.16S_8^{*} + 0.36S_{10}^{**} + 0.09S_{14}$	0.31	37.48^{**}
Lower Position Grasp Reach Height (D_{11})	$D_{11}=19.16 + 0.67S_1^{**} + 0.10S_4 - 0.35S_5^{**} - 0.14S_8 - 0.17S_{10} - 0.04S_{14}$	0.17	16.86^{**}
Forward Upper Position Reach Height (D_{18})	$D_{18}=23.83 + 0.11S_1 - 0.03S_4 + 0.27S_5^{**} + 0.21S_8^{**} + 0.59S_{10}^{**} + 0.27S_{14}^{**}$	0.53	92.65^{**}
Forward Middle Position Reach Height (D_{19})	$D_{19}=44.44 + 0.12S_1 - 0.01S_4 + 0.06S_5 + 0.18S_8^{**} + 0.35S_{10}^{**} + 0.05S_{14}$	0.31	36.91^{**}
Forward Lower Position Reach Height (D_{20})	$D_{20}=10.72 + 0.01S_1 - 0.02S_4 - 0.002S_5 + 0.09S_8^{*} +0.02S_{10} - 0.02S_{14}$	0.02	1.61 NS
Forward Upper Position Grasp Reach Height (D_{24})	$D_{24}=32.48 + 0.17S_1 - 0.06S_4 + 0.23S_5^{*} + 0.13S_8 + 0.43S_{10}^{**} + 0.31S_{14}^{**}$	0.45	68.07^{**}
Forward Middle Position Grasp Reach Height (D_{25})	$D_{25}= 46.79 + 0.17S_1^{*} - 0.04S_4 + 0.10S_5 + 0.20S_8^{**} + 0.28S_{10}^{**} + 0.03S_{14}$	0.30	35.10^{**}
Forward Lower Position Grasp Reach Height (D_{26})	$D_{26}= 24.8 - 0.15S_1^{*} + 0.007S_4 - 0.04S_5 + 0.08S_8 + 0.16S_{10}^{**} + 0.01S_{14}$	0.03	2.49^{*}

** Significant at 1% level of significance * Significant at 5% level of significance NS Non significant

4.7.2 Statistical Models For The Relationship Between Selected Standing Static and Horizontal Dynamic Anthropometry of Women

Statistical models explaining the relationship between selected standing static and horizontal dynamic anthropometry of women in standing position is presented in Table 124.

It is clear from the Table that the linear multiple regression models were better fit and has shown highly significant values for coefficient of multiple determination for the relationship between selected static and horizontal dynamic anthropometry of women in standing position. Coefficient of multiple determination explained more than 25 per cent of the variation in upward position length (R^2= 0.34), middle position length (R^2= 0.25), middle position grasp reach length (R^2= 0.29), forward middle position reach length (R^2= 0.33) and forward middle position grasp reach length (R^2= 0.31) due to selected set of static anthropometry.

It can be concluded from the Table that among the selected static anthropometric measurements normal standing height followed by hand length was having significant and positive effect on all the selected horizontal dynamic anthropometry of women in standing position. Elbow height did not reveal any significant effect on horizontal dynamic anthropometry of women in standing position.

Table 124 Statistical Models For Assessing Horizontal Dynamic Anthropometry of Women in Standing Position.

Dynamic Anthropometry	**Statistical Model** $\hat{Y}=b_0+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6$	**Coefficient of Multiple Determination (R^2)**	**F Value**
Upward Position Length (D_3)	$D_3= 13.7 + 0.36S_1^{**} - 0.22S_4^{**} + 0.69S_5^{**} - 0.08S_8 - 0.22S_{10}^{*} + 0.10S_{14}$	0.25	27.81^{**}
Middle Position Length (D_4)	$D_4=9.50 + 0.33S_1^{**} - 0.22S_4^{**} + 0.65S_5^{**} + 0.02S_8 -0.05S_{10} + 0.06S_{14}$	0.34	42.99^{**}
Lower Position Length (D_5)	$D_5=12.73 + .33S_1^{**} - 0.18S_4^{**} + 0.67S_5^{**} - 0.08S_8 - 0.23S_{10}^{**} + 0.10S_{14}$	0.24	26.37^{**}
Upper Position Grasp Reach Length (D_{12})	$D_{12}=11.11 + 0.31S_1^{**} - 0.19S_4^{**} + 0.64S_5^{**} - 0.06S_8 - 0.19S_{10}^{*} + 0.09S_{14}$	0.21	22.09^{**}
Middle Position Grasp Reach Length (D_{13})	$D_{13}=8.52 + 0.28S_1^{**} - 0.21S_4^{**} + 0.62S_5^{**} + 0.04S_8 -0.04S_{10} + 0.06S_{14}$	0.29	34.43^{**}
Lower Position Grasp Reach Length (D_{14})	$D_{14}=9.95 + 0.29S_1^{**} - 0.16S_4^{*} + 0.63S_5^{**} - 0.06S_8 - 0.21S_{10}^{*} + 0.10S_{14}$	0.20	21.13^{**}
Forward Upper Position Reach Length (D_{15})	$D_{15}=(-)\ 5.93 + 0.58S_1^{**} +0.06S_4 - 0.01S_5 - 0.13S_8 –0.36S_{10}^{**} + 0.22S_{14}^{*}$	0.17	16.63^{**}
Forward Middle Position Reach Length (D_{16})	$D_{16}=(-)8.54 + 0.28S_1^{*} - 0.12S_4 + 0.38S_5^{**} + 0.14S_8 + 0.16S_{10} + 0.22S_{14}^{**}$	0.33	41.53^{**}
Forward Lower Position Reach Length (D_{17})	$D_{17}= 26.31 + 0.60S_1^{**} + 0.07S_4 - 0.4S_5 - 0.23S_8 - 0.79S_{10}^{**} + 0.32S_{14}^{*}$	0.07	6.66^{**}
Forward Upper Position Grasp Reach Length (D_{21})	$D_{21}=(-)\ 8.07 + 0.74S_1^{**} + 0.02S_4 - 0.06S_5 - 0.14S_8 - 0.50S_{10}^{**} + 0.18S_{14}^{*}$	0.16	15.89^{**}
Forward Middle Position Grasp Reach Length (D_{22})	$D_{22}=(-)\ 13.93 + 0.34S_1^{**} - 0.13S_4 + 0.33S_5^{**} +0.06S_8 + 0.01S_{10} + 0.3S_{14}^{**}$	0.31	37.26^{**}
Forward Lower Position Grasp Reach Length (D_{23})	$D_{23}= 24.2 + 0.52S_1^{**} + 0.09S_4 - 0.44S_5^{*} - 0.22S_8 - 0.74S_{10}^{**} + 0.37S_{14}^{**}$	0.07	6.79^{**}

** Significant at 1 per cent level of significance * Significant at 5 per cent level of significance

4.7.3 Statistical Models For The Relationship Between Selected Squatting Static and Dynamic Anthropometry of Women

Statistical models explaining the relationship between selected squatting static and dynamic anthropometry of women is recorded in Table 125.

It is observed from the Table that the linear Multiple Regression Models were better fit and has shown highly significant values for coefficient of multiple determination for the relationship of selected static and dynamic anthropometric measurements of women in squatting posture. Coefficient of multiple determination explained that the selected set of static anthropometric measurements caused variation of 58 per cent of total variation in vertical arm reach of women in squatting posture followed by 30 per cent variation in vertical arm grasp reach and 20 per cent in middle position arm reach height of women in squatting posture.

It is clear from the models that hand length followed by normal squatting height had significant and positive influence on all selected dynamic measurements of women in squatting position. Right knee height and mid-shoulder height was having significant effect on equal number of dynamic anthropometry of women in squatting posture.

Thus, it can be said that the developed statistical model can explain the dynamic anthropometry of women in squatting posture.

Table 125 Statistical Models For Assessing Dynamic Anthropometry of Women in Squatting Position.

Dynamic Anthropometry	Statistical Model $\hat{Y} = b_0+b_1x_1+b_2x_2+b_3x_3+b_4x_4$	Coefficient of Multiple Determination (R^2)	F Value
Vertical Arm Reach (D_{27})	D_{27}=30.32+0.36 S_5^{**} +0.57S_{24}^{**}+0.31S_{26}^{**}+ 0.10S_{27}^{*}	0.58	172.19**
Vertical Arm Grasp Reach (D_{28})	D_{28}= 34.56+0.30S_5^{**} + 0.51S_{24}^{**}+0.29S_{26}^{**}+ 0.06S_{27}	0.30	53.15**
Upper Position Arm Reach Length (D_{29})	D_{29}= 58.29+0.08S_5 + 0.60S_{24}^{**} -0.75S_{26}^{**}-0.17S_{27}	0.08	10.57**
Middle Position Arm Reach Length (D_{30})	D_{30}= 34.10+0.43 S_5^{**} + 0.10S_{24} +0.035S_{26}+ 0.14S_{27}^{*}	0.18	27.92**
Lower Position Arm Reach Length (D_{31})	D_{31}= 26.08+0.43 S_5^{**} + 0.03S_{24} -0.023S_{26}+ 0.37S_{27}^{**}	0.22	35.95**
Upper Position Arm Reach Height (D_{32})	D_{32}= 61.92+0.18 S_5^{**} + 0.29S_{24}^{**} +0.11S_{26}+ 0.05S_{27}	0.16	23.53**
Middle Position Arm Reach Height (D_{33})	D_{33}= 26.04+0.10 S_5^{*} + 0.41S_{24}^{**} -0.04S_{26}- 0.05S_{27}	0.20	32.08**
Upper Position Grasp Reach Length (D_{34})	D_{34}= 49.37+0.06 S_5 + 0.55S_{24}^{**} -0.65S_{26}^{**}- 0.12S_{27}	0.07	8.89**
Middle Position Grasp Reach Length (D_{35})	D_{35}= 30.26+0.47S_5^{**} + 0.19S_{24}^{*} -0.035S_{26}+ 0.27S_{27}^{**}	0.17	26.16**
Lower Position Grasp Reach Length (D_{36})	D_{36}= 22.99+0.41 S_5^{**} - 0.01S_{24} -0.001S_{26}+ 0.41S_{27}^{**}	0.24	38.62**
Upper Position Grasp Reach Height (D_{37})	D_{37}= 59.26+0.19 S_5^{**} + 0.25S_{24}^{**} +0.15S_{26}^{*} + 0.054S_{27}	0.15	22.63**
Middle Position Grasp Reach Height (D_{38})	D_{38}= 22.99+0.11 S_5^{*} + 0.39S_{24}^{**} -0.03S_{26}- 0.06S_{27}	0.20	30.98**

** Significant at 1 per cent level of significance * Significant at 5 per cent level of significance

4.8 Testing Goodness of Fit of Developed Statistical Models

4.8.1 Applicability of Developed Statistical Models for Predicting Standing Vertical Dynamic Anthropometry of Women

Comparative assessment of observed and predicted vertical dynamic anthropometric measurements of women in standing position is presented in Table 126 and presented in Figure 85.

It is clear from the Table that mean values estimated through regression equation for majority of the vertical dynamic anthropometric measurements such as vertical upward grasp reach height, upper position grasp reach height, forward upper, middle and lower position grasp reach height were less than the actual measurements where as the mean estimated measurements for vertical upward arm reach from floor, upper and middle position height and middle position grasp reach height were slightly more than the actual measurements of women in standing position. Statistically the actual measurements were compared with predicted measurements by using χ^2 test for testing goodness of fit of equations The values of chi square were non significant at 1 per cent level of significance implying there by no significant difference between actual and predicted dynamic measurements.

Hence, it can be said that statistical models for vertical dynamic anthropometric measurements were proved to be fit for calculating vertical dynamic measurements of women in standing position.

Table 126 Testing Goodness of Fit of Developed Statistical Models for Assessment of Observed and Predicted Estimates of Standing Vertical dynamic Anthropometry of Women

Dynamic Anthropometry	**Observed Estimates (Mean) (Y)**	**Predicted Estimates (Mean) ($\hat{Y}$)**	**χ^2 Value**
Vertical Upward Arm Reach From Floor (D_1)	195.79	196.82	0.005 NS
Vertical Upward Grasp Reach (D_2)	187.84	187.11	0.003 NS
Upper Position Height (D_6)	188.6	188.90	0.005 NS
Middle Position Height (D_7)	129.28	129.49	0.003 NS
Lower Position Height (D_8)	68.23	74.01	0.45 NS
Upper Position Grasp Reach Height (D_9)	181.09	178.63	0.033 NS
Middle Position Grasp Reach Height (D_{10})	129.93	130.32	0.001 NS
Lower Position Grasp Reach Height (D_{11})	75.99	73.77	0.07 NS
Forward Upper Position Reach Height (D_{18})	176.96	175.83	0.007 NS
Forward Middle Position Reach Height (D_{19})	125.43	125.04	0.001 NS
Forward Lower Position Reach Height (D_{20})	17.66	17.17	0.014 NS
Forward Upper Position Grasp Reach Height (D_{24})	172.54	169.94	0.04 NS
Forward Middle Position Grasp Reach Height (D_{25})	126.53	125.97	0.002 NS
Forward Lower Position Grasp Reach Height (D_{26})	25.75	24.89	0.03 NS

NS Non significant

4.8.2 Applicability of Developed Statistical Models for Predicting Standing Horizontal Dynamic Anthropometry of Women

Comparative assessment of observed and predicted horizontal dynamic anthropometric measurements of women in standing position is presented in Table 127 and Figure 86.

It is evident from the Table that mean values estimated through regression equation were at par with the actual measurements for majority of the horizontal dynamic anthropometric measurements. Mean estimated values for middle position length, upper and lower position grasp reach length, forward middle and lower position grasp reach length were slightly less than actual measurements of women while the mean estimated measurements for middle position grasp reach length, forward upper, middle and forward upper position grasp reach length were more than the actual measurements of women in standing position.

Statistically the mean values for actual measurements of horizontal dynamic anthropometry of women were compared with predicted measurements through equation by applying χ^2 test. Meager values of χ^2 indicated non-significant difference between actual and predicted horizontal dynamic measurements of women in standing position. ($P \leq 0.01$)

Hence, it can be said that statistical models for horizontal dynamic anthropometric measurements were proved to be fit for calculating horizontal dynamic measurements of women in standing position.

Table 127 Testing Goodness of Fit of Developed Statistical Models for Assessment of Observed and Predicted Estimates of Horizontal Dynamic Anthropometry of Women in Standing Position.

Dynamic Anthropometry	Observed Estimates (Mean) (Y)	Predicted Estimates (Mean) ($\hat{Y}$)	χ^2 Value
Upward Position Length (D_3)	76.70	74.60	0.06NS
Middle Position Length (D_4)	83.52	82.91	0.004 NS
Lower Position Length (D_5)	74.34	72.00	0.07NS
Upper Position Grasp Reach Length (D_{12})	69.17	68.13	0.016 NS
Middle Position Grasp Reach Length (D_{13})	76.26	76.47	0.0006 NS
Lower Position Grasp Reach Length (D_{14})	67.00	66.87	0.0002 NS
Forward Upper Position Reach Length (D_{15})	76.37	77.51	0.17 NS
Forward Middle Position Reach Length (D_{16})	108.19	109.12	0.008 NS
Forward Lower Position Reach Length (D_{17})	55.36	51.65	0.27 NS
Forward Upper Position Grasp Reach Length (D_{21})	70.17	70.27	0.0001 NS
Forward Middle Position Grasp Reach Length (D_{22})	99.56	98.45	0.012 NS
Forward Lower Position Grasp Reach Length (D_{23})	51.27	50.89	0.003 NS

NS Non significant

4.8.3 Applicability of Developed Statistical Models for Predicting Squatting Dynamic Anthropometry of Women

Comparative assessment of observed and predicted dynamic anthropometric measurements of women in squatting position is noted in Table 128 and depicted in Figure 87.

It is obvious from the Table that the estimated values for Vertical arm reach, Vertical arm grasp reach, and Lower position arm reach length, Upper and lower position grasp reach length and middle position grasp reach height were less but at par with actual measurements of women in squatting position. The estimated mean values for upper position arm reach length and height, upper position grasp reach height and middle position grasp reach length were more than the actual measurements of women with slight difference. The observed measurements were compared with estimated measurements by using χ^2 test for goodness of fit. The values of χ^2 were non significant ($P \leq 0.01$).This implied that there was no significant difference between observed and predicted measurements of dynamic measurements of women in squatting posture.

It is concluded that the developed statistical models are statistically fit for calculating squatting dynamic measurements of women.

Table 128 Testing Goodness of Fit of Developed Statistical Models for Assessment of Observed and Predicted Estimates of Dynamic Anthropometry of Women in Squatting Position.

Dynamic Anthropometry	Observed Mean (y)	Predicted Mean ($\hat{Y}$)	χ^2 Value
Vertical Arm Reach (D_{27})	130.35	129.40	0.007 NS
Vertical Arm Grasp Reach (D_{28})	122.30	121.19	0.01 NS
Upper Position Arm Reach Length (D_{29})	56.4	57.27	0.013 NS
Middle Position Arm Reach Length (D_{30})	82.95	81.29	0.034 NS
Lower Position Arm Reach Length (D_{31})	75.09	73.69	0.026 NS
Upper Position Arm Reach Height (D_{32})	104.14	108.87	0.20 NS
Middle Position Arm Reach Height (D_{33})	63.51	63.13	0.002 NS
Upper Position Grasp Reach Length (D_{34})	52.66	51.62	0.021 NS
Middle Position Grasp Reach Length (D_{35})	76.8	89.06	1.69NS
Lower Position Grasp Reach Length (D_{36})	69.87	69.65	0.01 NS
Upper Position Grasp Reach Height (D_{37})	100.13	106.35	0.36 NS
Middle Position Grasp Reach Height (D_{38})	59.57	59.29	0.001 NS

NS Non significant

4.9 Testing of Hypothesis

The Statistical analysis between static and dynamic anthropometry of women in standing and squatting position indicated positive correlation between selected static and dynamic anthropometry of women. Results further, revealed that normal standing height, mid-shoulder height, hand length, elbow height, waist height and span are the better predictors to determine standing dynamic anthropometry of women and hand length, normal squatting height, mid-shoulder height and right knee height are the better predictors to determine squatting static anthropometry of women. Thus the null hypothesis set in the present investigation that "The correlation between static and dynamic anthropometry of women is zero" is rejected and **"Dynamic anthropometry of women is related with static anthropometry of women"** is accepted.

On the whole results in the study determined the normality of data. The statistical descriptors of static and dynamic anthropometry of women in standing and squatting posture are available in the form of mean, maximum, minimum and fifth and ninety-fifth percentile values. Thus, the data reveals average measurements of 90 per cent of women along with the information of minimum and maximum limit of static and dynamic measurements. The mean values of vertical reaches serve as a convenient reach limit for various height groups and can be considered for vertical length of design problem. Whereas, the horizontal reaches serve as a reference point to decide suitable width or diameter of design problem. The different percentile group of different measurements can be utilized for general group in context of specific design problem. The statistical relationship proved in the research can derive 38 dynamic measurements for women in standing & squatting position with the known measurements of women like normal standing height, mid shoulder height, elbow height, hand length, waist height and span, normal squatting height, squatting mid shoulder height and right knee height of women.

SUMMARY

Effective man-machine coordination depends on ergonomic design of the workstation. Continuous working on improper workstation lay out leads to the development of musculo-skeletal disorders and severe health problems. Workstations should be designed according to the human body dimensions. Thus, the need for anthropometric database becomes increasingly important and grows in parallel with the goal to achieve efficient system designs. Hence, the study entitled "Statistical Modeling of Relationship Between Static and Dynamic Anthropometry of Women" was carried out with the objective of studying the relationship between static and dynamic anthropometry of women and to develop the statistical models based on the assessed relationship between static and dynamic anthropometry of women for predicting dynamic measurements of women in standing and squatting postures. The static and dynamic anthropometry of randomly selected 500 women from Parbhani was recorded in predefined observation schedule. The data was analysed by applying simple correlation, multiple regression analysis and χ^2 test was applied to test goodness of fit of developed statistical models.

The study gives representative scenario of anthropometry of women. This will be helpful in planning workplaces and in turn reduce physical strain of the worker. The research presents useful compilation of anthropometric data of Maharashtrian women population residing in Parbhani and representative of somatic characteristics of women from Marathwada region. The approach provides framework and can be used in conjunction with many commonly used workstations.

The salient findings of the investigation are summarized here under.

The findings regarding demographical characters of selected subjects revealed that majority of the women surveyed were between the age group of 25-35 years, college educated, having monthly income between Rs.5000 and Rs.10000. Majority of the women were belonging to nuclear families and having 1-4 and 5-8 members in the family.

Wide variations are observed for the static and dynamic anthropometry of selected women in standing and squatting position, body depth and breadth measurements as well as circumference measurements of selected women, which may be due to varied, body built of women.

Simple correlation and multiple regression analysis were calculated to find out the relationship between selected static anthropometric measurements and dynamic measurements of women. Further, the coefficient of determination was calculated to see which extent these dimensions are related to each other. The Selected set of static anthropometry consisted of normal standing height, mid-shoulder height, elbow height, waist height, hand length and span which was correlated with vertical dynamic anthropometry of women in standing position. It is clear from the findings that all the static variables selected are having positive correlation with vertical upward arm reach and grasp reach which indicated that the vertical upward arm reach and grasp reach increases with an increase in the selected set of static anthropometry. The length measurements at upper, middle, lower position and grasp reach length of women at upper, middle and lower position are also having a positive correlation with selected set of static measurements of women in standing position ($P \leq 0.01$) indicating that the increase in all the selected static anthropometry increases the length measurements of women in open and grasp hand. The complete set of selected static anthropometry showed positive effect on arm reach height, grasp reach height, forward reach length, forward reach height, forward grasp reach length and forward grasp reach height at upper and middle position indicating that as there was increase in selected set of static anthropometry the said measurements increased at upper and middle position. The lower position grasp reach height was found to be correlated with normal standing height, mid-shoulder height, elbow height and waist height of women which was indicative of the fact that as the normal standing height increases above said measurements increased proportionately. Forward lower position reach length of women was not correlated with any of the selected static anthropometry. Forward lower position reach height showed positive correlation with elbow height whereas, forward lower position grasp reach height was correlated with waist height of women. This indicated that the increase in elbow height increases forward lower position reach height of women and increase in waist height increases forward lower position grasp reach height of women in standing position. ($P \leq 0.01$)

Application of multiple regression analysis revealed that the selected set of standing static anthropometric measurements caused more than 50 per cent of variation in vertical upward arm reach, vertical upward grasp reach, upper position height, middle position height, upper position grasp reach height and forward upper position reach height of women in standing position. Thus, revealing the fact that selected set of anthropometric measurements is responsible to cause significant variation in above said vertical dynamic measurements of women in standing position.

The total effect within the range of 25-50 per cent by the selected set of static anthropometry was noticed on upward position length; middle position length, forward middle position reach length, forward middle position grasp reach length and middle position reach length.

The selected static standing variables caused 25 to 50 per cent variation on Forward middle position reach height, forward upper position grasp reach height and forward middle position grasp reach height of women in standing position.

Path analysis indicated that normal standing height and span of women were the major static anthropometric measurements causing variation in vertical upward arm reach of women, vertical upward grasp reach, middle position reach height, forward middle position reach length and forward middle position grasp reach length of women in standing position.

Normal standing height and hand length contributed to be important static anthropometry for determining the upward position length, middle position length, lower position length, lower position height, lower position grasp reach height, upper position grasp length, lower position grasp length of women in standing position. Substantial indirect effect of normal standing height, waist height and span was noticed on upper position height and forward lower position grasp reach length of women in standing position. Substantial indirect effect of selected set of static anthropometry on upper position grasp reach height, forward upper position reach height and forward upper position grasp reach height was noticed through waist height and span of women in standing position.

Substantial indirect effect of static anthropometry through normal standing height and waist height was recorded on middle position grasp reach height, forward upper position reach length, forward lower position reach length, forward upper position grasp reach length, forward middle position grasp reach height and forward lower position grasp reach height of women in standing position. Substantial indirect effect of selected static anthropometric measurements on middle position grasp length was noticed through mid-shoulder height and hand length of women in standing position. Effect of selected static anthropometry on forward middle position reach height was recorded through elbow height and span of women in standing position.

Selected set of static measurements like hand length, squatting height, squatting mid-shoulder height and right knee height correlated with selected dynamic anthropometry of women in squatting posture. It was observed from the study that all the four static measurements were positively correlated with vertical arm reach of women, vertical arm grasp reach, middle and lower position arm reach length, upper position arm reach height, middle and lower position grasp reach length and upper position reach height of women in squatting posture ($P \leq 0.01$). This indicated that the increase in hand length, normal squatting height, right knee height and mid-shoulder height caused the increase in above-mentioned dynamic measurements of women in squatting posture. Normal squatting height and mid-shoulder height showed positive correlation with middle position arm and grasp reach height of women in squatting posture. It was interesting to note from the study that mid-shoulder height showed negative correlation with arm reach length and grasp reach length at upper position. This explains that as there was increase in mid-shoulder squatting height the arm reach length and grasp reach length of women decreased proportionately.

Multiple regression analysis indicated 53 per cent impact of selected set of squatting static anthropometry on squatting vertical arm reach of women, whereas, the total impact of these static measurements was very less on other dynamic measurements of women in squatting position.

Path analysis revealed a substantial effect of normal squatting height and mid-shoulder height on vertical arm reach, vertical arm grasp reach, upper position arm reach length, upper position arm reach height and middle position grasp reach height of women whereas, the effect of normal squatting height and right knee height was noticed on middle position arm reach length, lower position arm reach length, middle position grasp reach length and lower position grasp reach length of women in squatting position.(Appendix II)

It is clear from the study that the developed linear multiple regression models are better fit and has shown highly significant value of coefficient of multiple determination ($P \leq 0.01$) for selected vertical dynamic anthropometry of women except for forward lower position reach height of women in standing position. All the selected static anthropometric measurements except mid-shoulder height influence vertical dynamic anthropometry of women in standing position.

It is clear from the findings that the developed linear multiple regression models are better fit and has shown highly significant value of coefficient of multiple determination ($P \leq 0.01$) for the relationship between selected standing static and horizontal dynamic anthropometry of women in standing position. It can be concluded from the study that among the selected static anthropometric measurements normal standing height followed by hand length was having significant and positive effect on all the selected horizontal dynamic anthropometry of women in standing position. Elbow height did not reveal any significant effect on horizontal dynamic anthropometry of women in standing position.

It is observed that the linear multiple regression models are better fit and has shown highly significant value of coefficient of coefficient of multiple determination ($P \leq 0.01$) for the relationship of selected static and dynamic anthropometric measurements of women in squatting posture.

It is clear from the models that normal squatting height had significant and positive influence ($P \leq 0.01$) on all selected dynamic measurements of women in squatting position except on lower position arm reach and grasp reach length. Right knee height and mid-shoulder height was having approximately equal effect on dynamic anthropometry of women in squatting posture.

Estimated dynamic anthropometric measurements were slightly different from the actual measurements of selected women in standing and squatting position. Hence, it can be said that developed statistical models are proved to be fit for calculating vertical and horizontal dynamic measurements of women in standing as well as in squatting posture. Application of χ^2 indicated non-significant values of comparative assessment of observed and predicted dynamic anthropometry; thus, the goodness of fit is proved for the developed statistical models.

Thus, the null hypothesis set " The static anthropometry of women do not have relationship with dynamic measurements " is rejected as the findings indicated that the majority of the static body dimensions have direct and positive relationship with majority of the dynamic measurements of women in standing as well as squatting position.

The results of research work provide representative somatic characteristics of women in Marathwada region. Experimental study has generated structural and functional dimensions required in the determination of normal work areas. These constitute the complement to the set of data of the population for the needs of designers. The results of the research work can be used for the design or adaptation of workplaces, flats, interior facilities, and devices, social care centers as well as for designing clothes. Research based anthropometric data can widely be used to eliminate or to minimize mismatch between workers and their working environments. Multiple regression analysis carried out in the study leads to an effective anthropometry interrelation basis. With the statistical models developed in this study it is possible to predict the functional dimensions of women. Models can transfer the raw data into applicable data. For promoting ergonomics establishing an anthropometric database is a milestone. However applying the data in our daily life is more relevant. The real value of database lies in its applications. An anthropometric database is a pre requisite for designers and engineers if they want to design ergonomic products and facilities. This database is important for users as well as if they desire to use ergonomically designed products and facilities.

Developed models can serve as a good approximation in the absence of better data preferably measured directly from the individual, thus, serving as a reference tool in the designing workplaces. It is impractical to measure dynamic anthropometry repeatedly, so relationship between static and dynamic anthropometry derived for Indian women as depicted can be utilized and functional dimension required in the specific context can be derived through these equations. Developed statistical models for standing anthropometry can predict 12 horizontal standing dynamic measurements and 14 vertical standing dynamic measurements through the record of only 6 standing static measurements. Similarly the set of 12 squatting dynamic anthropometric measurements can be predicted through the record of 4 squatting static measurements of women with developed statistical model for squatting anthropometry. Dynamic dimensions of the body help in establishing the maximum and minimum levels of working heights and would also help in the organisation of storage and placement of equipment. It is important for engineering designers especially product designers in the housing and construction industries to consider functional capabilities and limitations of older adults when designing products of daily use and daily living environments.

The anthropometric data collected in this study provide the designers and engineers the basis for designing safe, healthy and comfortable work environment and facilities. Data can further be analysed and used for inventory planning to meet the market demand. Establishing accurate recommendations is a key to good design. It is recommended that Table should not be used for establishing design limits; rather local or regional data should be used, as the local or regional population trends could be substantially different from national trends. It is also recommended that a larger study that includes most critical body dimensions be carried out and actual percentile values for these body dimensions be established to make the design recommendations realistic and more meaningful.

Study has laid groundwork for improving the worker's safety. Thus, the findings have practical implications for worker, ergonomists, space planners and designers. The information is important for researchers who use human form databases in evaluating human machine interfaces and personal protective equipment, for designers who formulate anthropometric guides for the development and selection of correct sizes of personal protective equipment and for anthropometry research managers in determining their sampling strategies. Based on the models developed in the study further investigation can be undertaken on designing of different work areas, equipment and furniture suitable to the worker.

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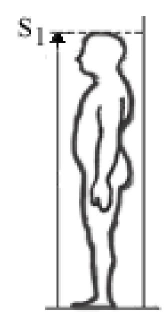
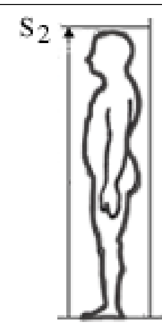
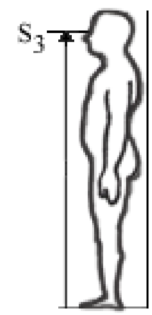
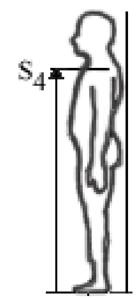
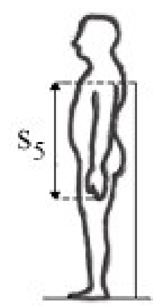
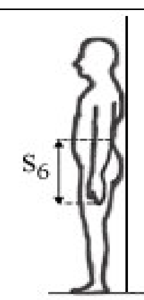
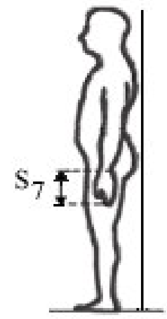
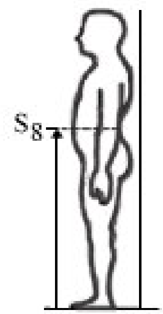
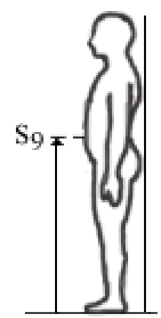
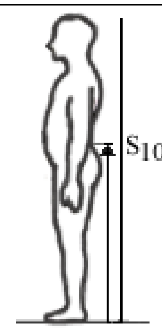
APPENDIX I

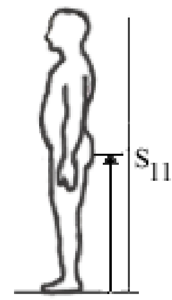
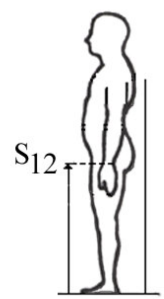
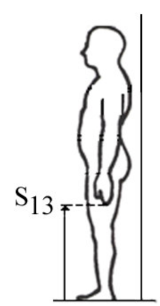
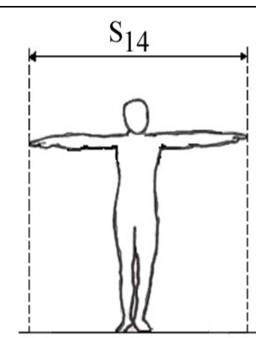
INTERVIEW AND OBSERVATION SCHEDULE TO RECORD THE INFORMATION ON STATIC AND DYNAMIC ANTHROPOMETRY OF WOMEN.

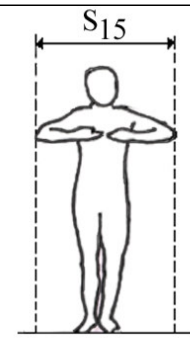
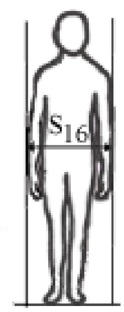
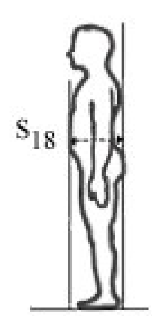
1. Name of the woman: ---
2. Age of Woman: ---------------- Yrs
3. Education of Woman: ------------
4. Monthly Family Income: ----------------- Rs.
5. Type of Family: Joint / Nuclear
6. Number of Family Members: ------------
7. OBSERVATION SCHEDULE:

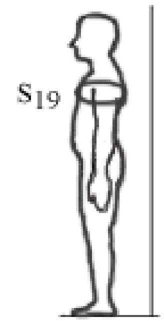
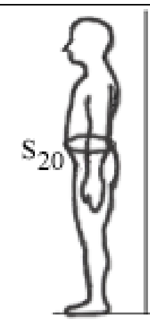
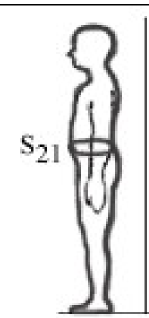
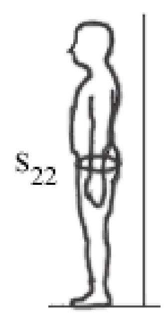
Sr. no.	Anthropometric Measurements (cm)	Illustration
1	**Normal Standing (S_1)**: ------------	
2	**Stature (S_2):** ------------	

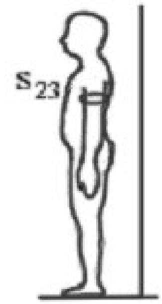
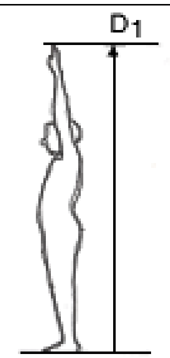
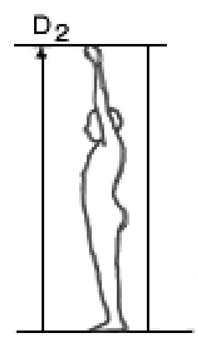
Sr. no.	Anthropometric Measurements (cm)	Illustration
3	**Eye Height (S_3):** ------------	
4	**Mid-Shoulder Height (S_4)**: --------	
5	**Hand Length (S_5)**: ------------	
6	**Elbow to Middle Finger (S_6)**: -----	

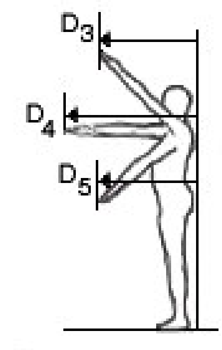
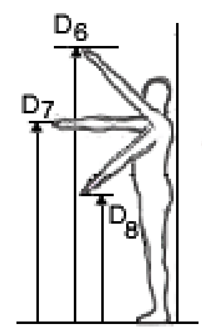
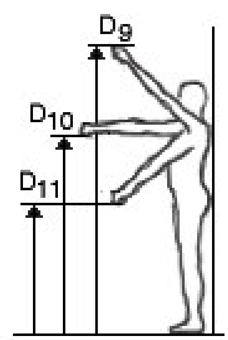
Sr. no.	Anthropometric Measurements (cm)	Illustration
7	**Palm Length (S_7)**: -------------	
8	**Elbow Height (S_8):** -----------	
9	**Abdominal Extension Height (S_9)**: -----	
10	**Waist Height (S_{10})**: --------------	

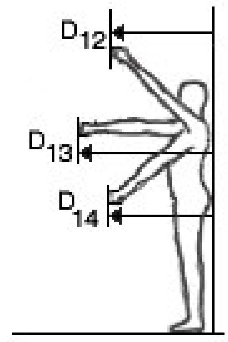
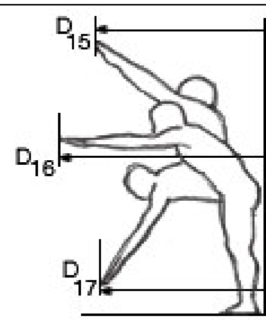
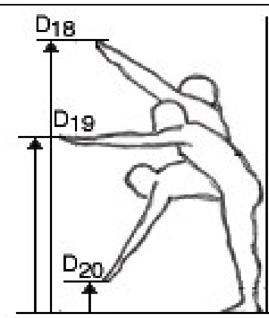
Sr. no.	Anthropometric Measurements (cm)	Illustration
11	**Buttock Extension Height (S_{11})**: - -	
12	**Tip of Radius Height (S_{12}): -------** -	
13	**Dactylion Height (S_{13})**: ------------	
14	**Span (S_{14}): -----------------**	

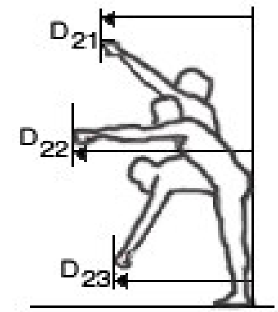
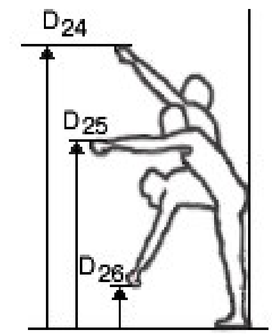
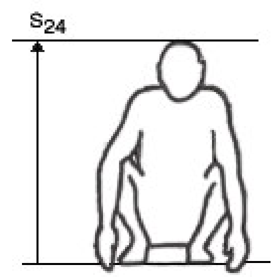
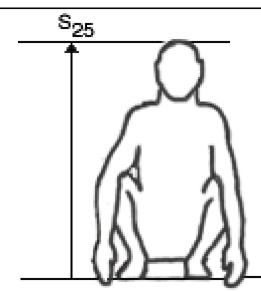
Sr. no.	Anthropometric Measurements (cm)	Illustration
15	**Span Akimbo (S_{15}): ----------------**	
16	**Maximum Body Breadth, Relaxed (S_{16}): ------------**	
17	**Chest Depth (S_{17}): -------------**	
18	**Maximum Body Depth, Relaxed (S_{18}): -----------**	

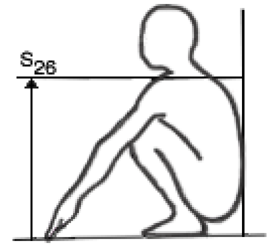
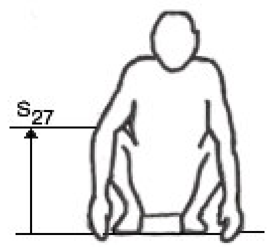
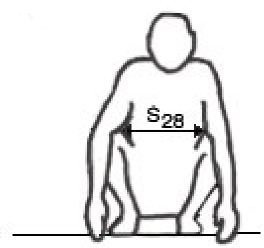
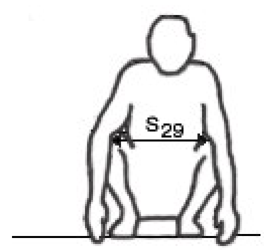
Sr. no.	Anthropometric Measurements (cm)	Illustration
19	**Chest (mid tidal) on Bust (S_{19}): ---**	
20	**Abdominal Extension (S_{20}): -------**	
21	**Waist Circumference (S_{21}): ------**	
22	**Hip at Gluteal Extension (S_{22}):---**	

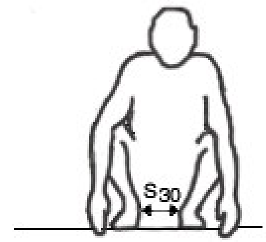
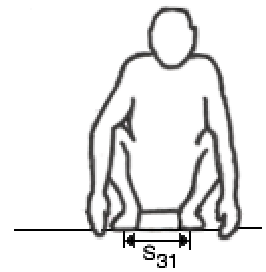
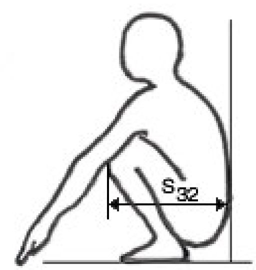
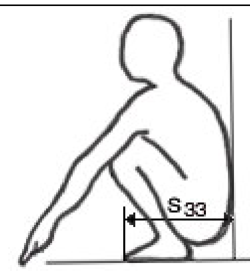
Sr. no.	Anthropometric Measurements (cm)	Illustration
23	**Arm Circumference (S_{23}): --------**	
24	**Vertical Upward Arm Reach (D_1): ---------------**	
25	**Vertical Upward Grasp Reach (D_2): --------**	

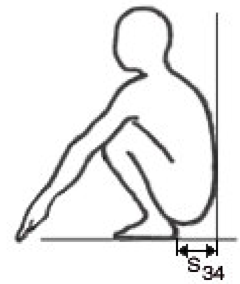
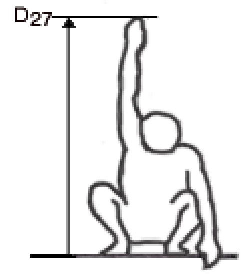
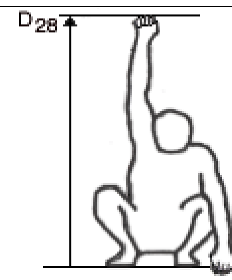
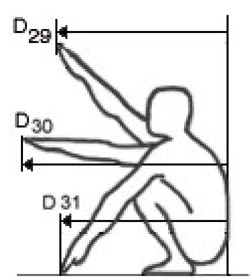
Sr. no.	Anthropometric Measurements (cm)	Illustration
26	**Arm Reach Length at** **Upper Position (D_3): ------------** **Mid Position (D_4):-----------** **Lower Position (D_5): ---------------**	
27	**Arm Reach Height at** **Upper Position (D_6): ------------** **Mid Position (D_7): ------------** **Lower Position (D_8): -------------**	
28	**Grasp Reach Height at** **Upper Position (D_9): ---------------** **Mid Position (D_{10}): ------------** **Lower Position (D_{11}): --------------**	

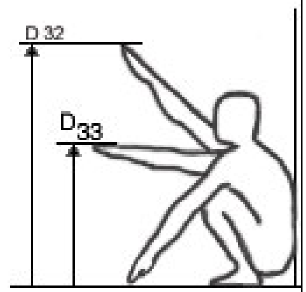
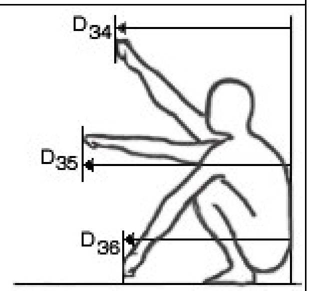
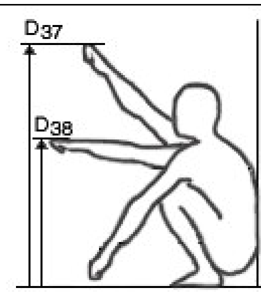
Sr. no.	Anthropometric Measurements (cm)	Illustration
29	**Grasp Reach Length at** **Upper Position (D_{12}): -------------** **Mid Position (D_{13}): -------------** **Lower Position (D_{14}): --------------**	
30	**Arm Reach Length at** **Forward Upper Position (D_{15}):--** **Forward Mid Position (D_{16}):-** **Forward Lower Position (D_{17})**:---	
31	**Arm Reach Height at** **Forward Upper Position (D_{18}):--** **Forward Mid Position (D_{19}):-** **Forward Lower Position (D_{20}):---**	

Sr. no.	Anthropometric Measurements (cm)	Illustration
32	**Grasp Reach Length at** **Forward Upper Position (D_{21}):--** **Forward Mid Position (D_{22}):-** **Forward Lower Position (D_{23}): --**	
33	**Grasp Reach Height at** **Forward Upper Position (D_{24}): --** **Forward Mid Position (D_{25}):-** **Forward Lower Position (D_{26}): --**	
34	**Normal Squatting Height (S_{24}): -**	
35	**Erect Squatting Height (S_{25}):-----**	

Sr. no.	Anthropometric Measurements (cm)	Illustration
36	**Mid-Shoulder Squatting Height (S_{26}): -----**	
37	**Right Knee Height (S_{27}): ----------**	
38	**Elbow to Elbow Distance, Relaxed (S_{28})**: ----------	
39	**Knee to Knee Distance, Relaxed (S_{29}): -----**	

Sr. no.	Anthropometric Measurements (cm)	Illustration
40	**Heel to Heel Distance (S_{30}): -------**	
41	**Big toe to Big toe Distance (S_{31}):--**	
42	**Buttock to Knee Length (S_{32}): ----**	
43	**Buttock to Foot Distance (S_{33}): --**	

Sr. no.	Anthropometric Measurements (cm)	Illustration
44	**Buttock to Heel Distance (S_{34}): --**	
45	**Squatting Vertical Arm Reach (D_{27}): -------**	
46	**Squatting Vertical Grasp Reach (D_{28}): -----------**	
47	**Squatting Arm Reach Length at** **Upper Position (D_{29}): -------------** **Mid Position (D_{30}): ------------** **Lower Position (D_{31})**: -------------	

Sr. no.	Anthropometric Measurements (cm)	Illustration
48	**Squatting Arm Reach Height at** **Upper Position(D_{32}):-------------** **Mid Position (D_{33})**: -----------	
49	**Squatting Grasp Reach Length** **at** **Upper Position (D_{34}): -------------** **Mid Position (D_{35}): ------------** **Lower Position (D_{36})**: -------------	
50	**Squatting Grasp Reach Height** **at** **Upper Position (D_{37}): -------------** **Mid Position (D_{38}): ------------**	

APPENDIX II

SUMMARY CHART OF DIRECT AND INDIRECT EFFECT OF STATIC ANTHROPOMETRY ON DYNAMIC ANTHROPOMETRY OF WOMEN.

Sr. no.	Dynamic Anthropometry	Direct Effect	Substantial Indirect Effect of Static Anthropometry	Through the Static Anthropometry
1	Vertical Upward Arm Reach	Normal standing height and Span	Normal standing height Mid-shoulder height, hand length, elbow height, waist height and span	Span Normal standing height
2	Vertical Upward Grasp Reach	Normal standing height and Span	Normal standing height Mid-shoulder height, hand length, elbow height, waist height and span-	Span Normal standing height
3	Upper Position Arm Reach Length	Hand length and Normal standing height	Normal standing height, mid-shoulder height and span Hand length, elbow height and waist height	Hand length Normal standing height

Sr. no.	Dynamic Anthropometry	Direct Effect	Substantial Indirect Effect of Static Anthropometry	Through the Static Anthropometry
4	Mid Position Arm Reach Length	Hand length and Normal standing height	Normal standing height, Mid-shoulder height and span Hand length, Waist height and elbow height	Hand length Normal standing height
5	Lower Position Arm Reach Length	Hand length and Normal standing height	Normal standing height, mid-shoulder height, Waist height and span Hand length, and elbow height	Hand length Normal standing height
6	Upper Position Arm Reach Height	Waist height, normal standing height and span followed by hand length	Standing height Mid-shoulder height, elbow height, waist height and span Hand length	Waist height Normal standing height Span

Sr. no.	Dynamic Anthropometry	Direct Effect	Substantial Indirect Effect of Static Anthropometry	Through the Static Anthropometry
7	Mid Position Arm Reach Height	Normal standing height and Span	Normal standing height Mid-shoulder height, hand length, elbow height, waist height and span	Span Normal standing height
8	Lower Position Arm Reach Height	Normal standing height	Mid-shoulder height, hand length, elbow height, waist height and span	Normal standing height
9	Upper Position Grasp Reach Height	Waist height and span	Normal standing height, mid-shoulder height, hand length, elbow height and span Waist height	Waist height Span
10	Mid Position Grasp Reach Height	Waist height and Normal standing height	Normal standing height, mid-shoulder height, hand length, elbow height and span Waist height	Waist height Span

Sr. no.	Dynamic Anthropometry	Direct Effect	Substantial Indirect Effect of Static Anthropometry	Through the Static Anthropometry
11	Lower Position Grasp Reach Height	Normal standing height	Normal standing height Mid-shoulder height, hand length, elbow height, span and Waist height	Waist height (-) Normal standing height
12	Upper Position Grasp Reach Length	Hand length and Normal standing height	Normal standing height, mid-shoulder height, elbow height, span and Waist height Hand length	Hand length Normal standing height
13	Mid Position Grasp Reach Length	Hand length and Normal standing height	Normal standing height, mid-shoulder height, elbow height, span and Waist height Hand length	Hand length Mid-shoulder height (-)

Sr. no.	Dynamic Anthropometry	Direct Effect	Substantial Indirect Effect of Static Anthropometry	Through the Static Anthropometry
14	Lower Position Grasp Reach Length	Hand length and Normal standing height	Normal standing height, mid-shoulder height, elbow height, span and Waist height Hand length	Hand length Normal standing height
15	Forward Upper Position Arm Reach Length	Normal standing height and span Waist height (-)	Normal standing height Mid-shoulder height, Hand length, elbow height, Waist height and span	Waist height (-) Normal standing height
16	Forward Mid Position Arm Reach Length	Normal standing height and Hand length	Normal standing height and Hand length Mid-shoulder height, elbow height span and Waist height	Span Normal standing height

Sr. no.	Dynamic Anthropometry	Direct Effect	Substantial Indirect Effect of Static Anthropometry	Through the Static Anthropometry
17	Forward Lower Position Arm Reach Length	Normal standing height (+) Waist height and span (-)	Normal standing height Mid-shoulder height, Hand length, elbow height, Waist height and span	Waist height (-) Normal standing height
18	Forward Upper Position Arm Reach Height	Waist height and span	Normal standing height, mid-shoulder height, Hand length, elbow height and span Waist height	Waist height Span
19	Forward Mid Position Arm Reach Height	Waist height, elbow height followed by normal standing height	Normal standing height, mid-shoulder height, Hand length, elbow height and span Waist height	Waist height Elbow height
20	Forward Lower Position Arm Reach Height	Elbow height	Normal standing height	Elbow height

Sr. no.	Dynamic Anthropometry	Direct Effect	Substantial Indirect Effect of Static Anthropometry	Through the Static Anthropometry
21	Forward Upper Position Grasp Reach Length	Normal standing height and span (+) Waist height (-)	Normal standing height Mid-shoulder height, Hand length, elbow height, Waist height and span	Waist height (-) Normal standing height
22	Forward Mid Position Grasp Reach Length	Span, normal standing height followed by hand length	Normal standing height and hand length Mid-shoulder height, Elbow height, Waist height and span	Span Normal standing height
23	Forward Lower Position Grasp Reach Length	Normal standing height and Span (+) Waist height (-)	Normal standing height and hand length and elbow height Mid-shoulder height and span Waist height	Waist height (-) Normal standing height Span

Sr. no.	Dynamic Anthropometry	Direct Effect	Substantial Indirect Effect of Static Anthropometry	Through the Static Anthropometry
24	Forward Upper Position Grasp Reach Height	Span and waist height followed by normal standing height	Normal standing height, mid-shoulder height, hand length and Waist height Elbow height and span	Span Waist height
25	Forward Mid Position Grasp Reach Height	Waist height, Normal standing height and elbow height	Normal standing height, mid-shoulder height, Hand length, elbow height, and span Waist height	Waist height Normal standing height
26	Forward Lower Position Grasp Reach Height	Waist height and elbow height Normal standing height (-)	Normal standing height Mid-shoulder height, Hand length, elbow height, Waist height and span	Waist height Normal standing height (-)

Sr. no.	Dynamic Anthropometry	Direct Effect	Substantial Indirect Effect of Static Anthropometry	Through the Static Anthropometry
27	Squatting Vertical Arm Reach	Normal squatting height, hand length and mid-shoulder height	Mid-shoulder height Normal squatting height	Normal squatting height Mid-shoulder height
28	Squatting Vertical Arm Grasp Reach	Normal squatting height, mid-shoulder height and hand length	Normal squatting height Mid-shoulder height	Mid-shoulder height Normal squatting height
29	Squatting Upper Position Arm Reach Length	Normal squatting height (+) and Mid-shoulder height (-)	Normal squatting height Mid-shoulder height	Mid-shoulder height (-) Normal squatting height
30	Squatting Mid Position Arm Reach Length	Hand length	Right knee height	Hand length
31	Squatting Lower Position Arm Reach Length	Hand length and right knee height	Right knee height	Hand length
32	Squatting Upper Position Arm Reach Height	Normal squatting height and hand length	Mid-shoulder height	Normal squatting height
33	Squatting Mid Position Arm Reach Height	Normal squatting height	Mid-shoulder height	Normal squatting height

Sr. no.	Dynamic Anthropometry	Direct Effect	Substantial Indirect Effect of Static Anthropometry	Through the Static Anthropometry
34	Squatting Upper Position Grasp Reach Length	Normal squatting height and Mid-shoulder height (-)	Normal squatting height Mid-shoulder height	Mid-shoulder height (-) Normal squatting height
35	Squatting Mid Position Grasp Reach Length	Hand length	Right knee height	Hand length
36	Squatting Lower Position Grasp Reach Length	Hand length and right knee height	Right knee height	Hand length
37	Squatting Upper Position Grasp Reach Height	Normal squatting height and Hand length and Mid-shoulder height	Normal squatting height Mid-shoulder height	Mid-shoulder height Normal squatting height
38	Squatting Mid Position Grasp Reach Height	Normal squatting height	Mid-shoulder height	Normal squatting height

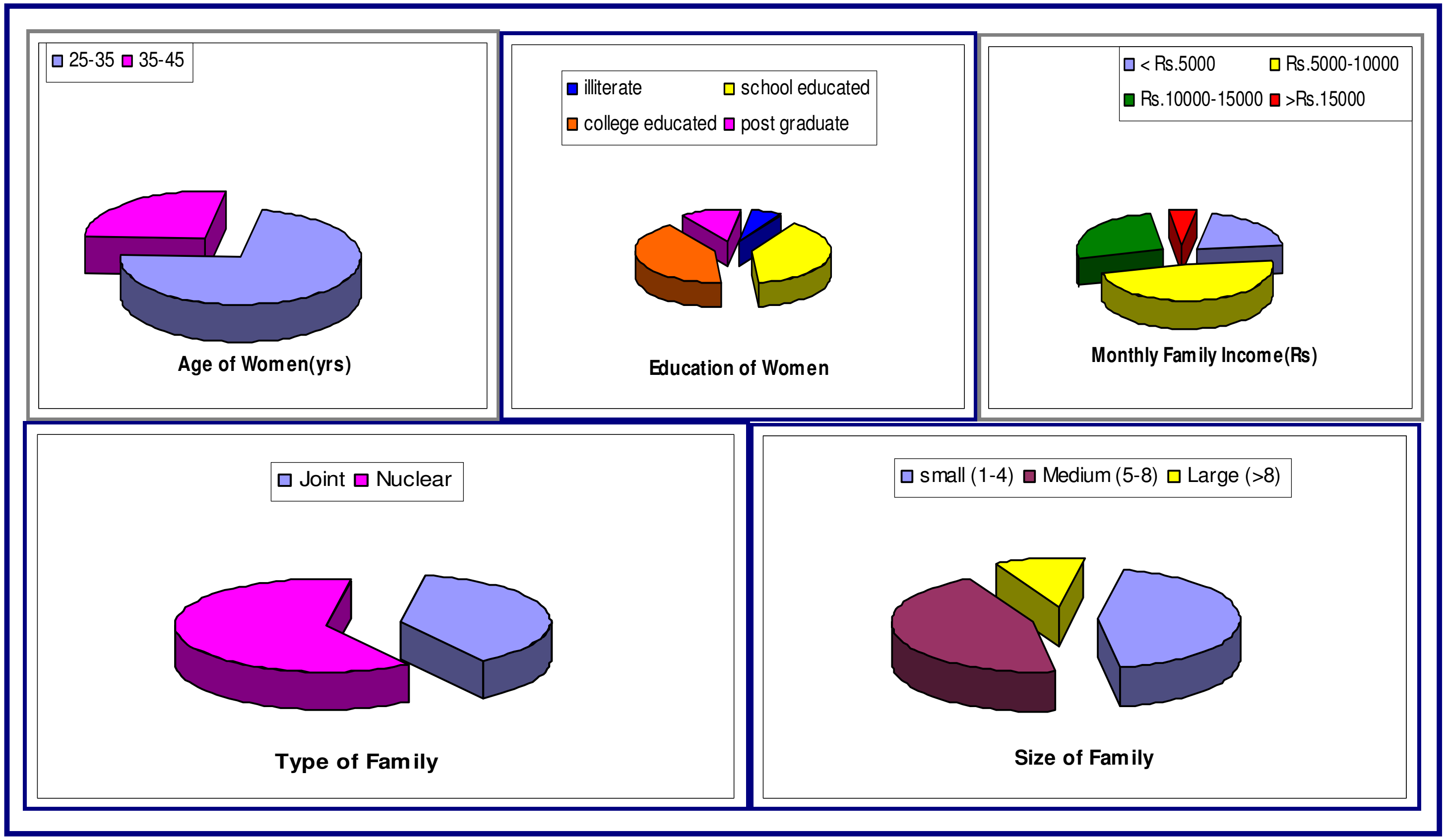


Figure 1: Demographic information of selected women

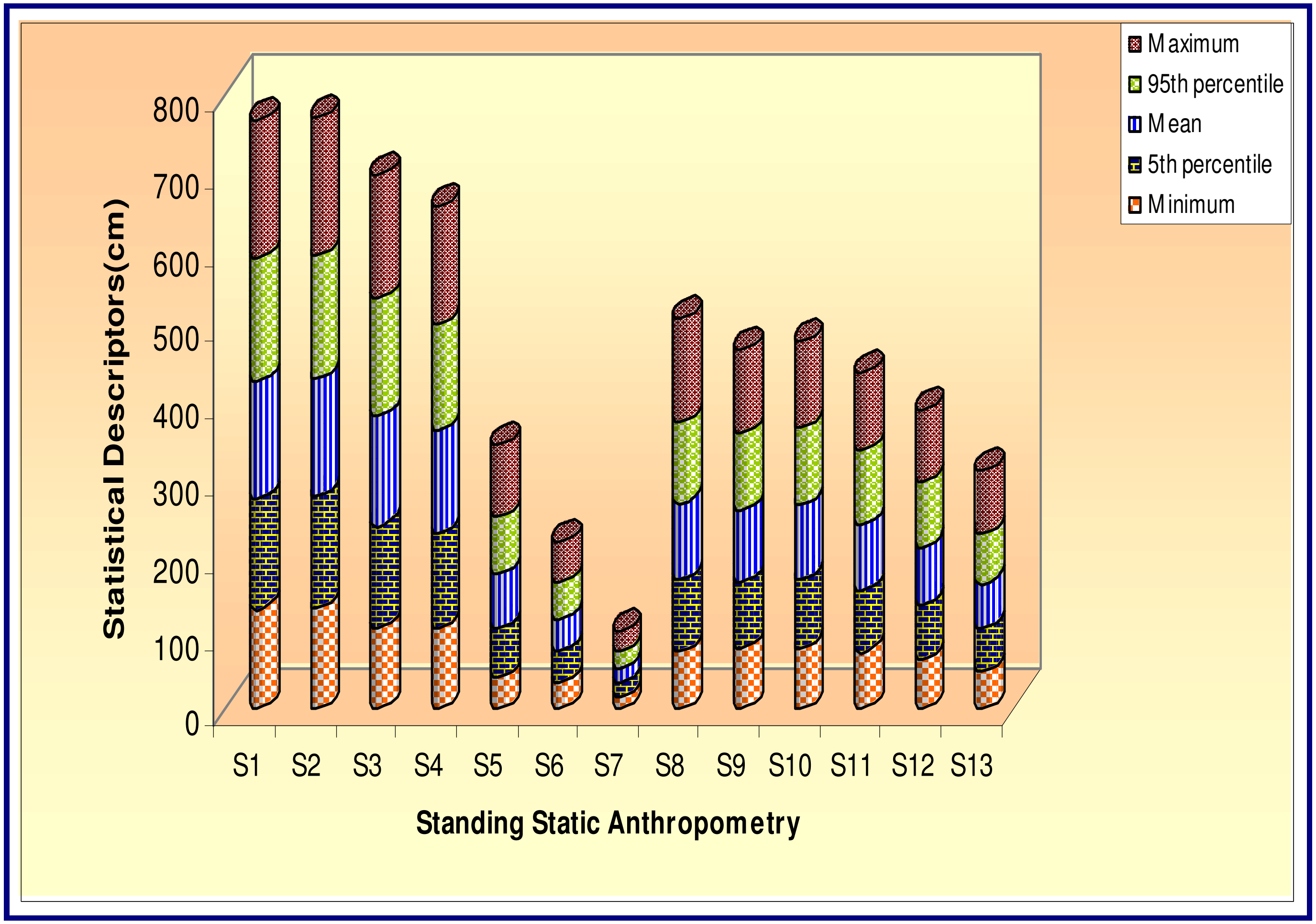


Figure 2: **Statistical descriptors of standing static anthropometry of selected women**

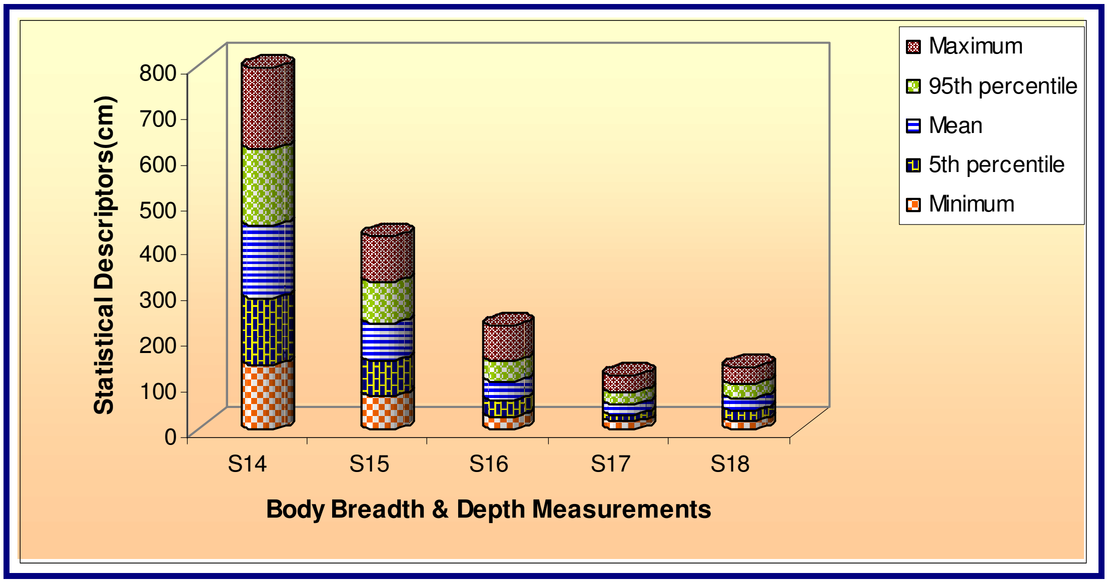


Figure 3: **Statistical descriptors of breadth & depth measurements of selected women**

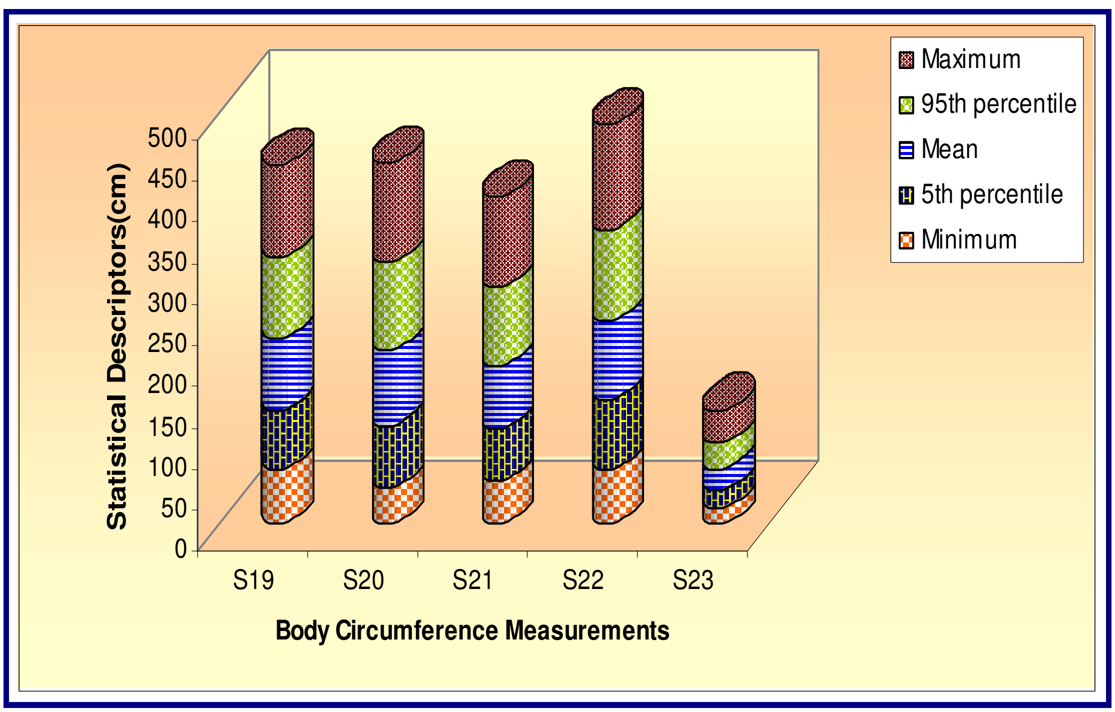


Figure 4: **Statistical descriptors of circumference measurements of selected women.**

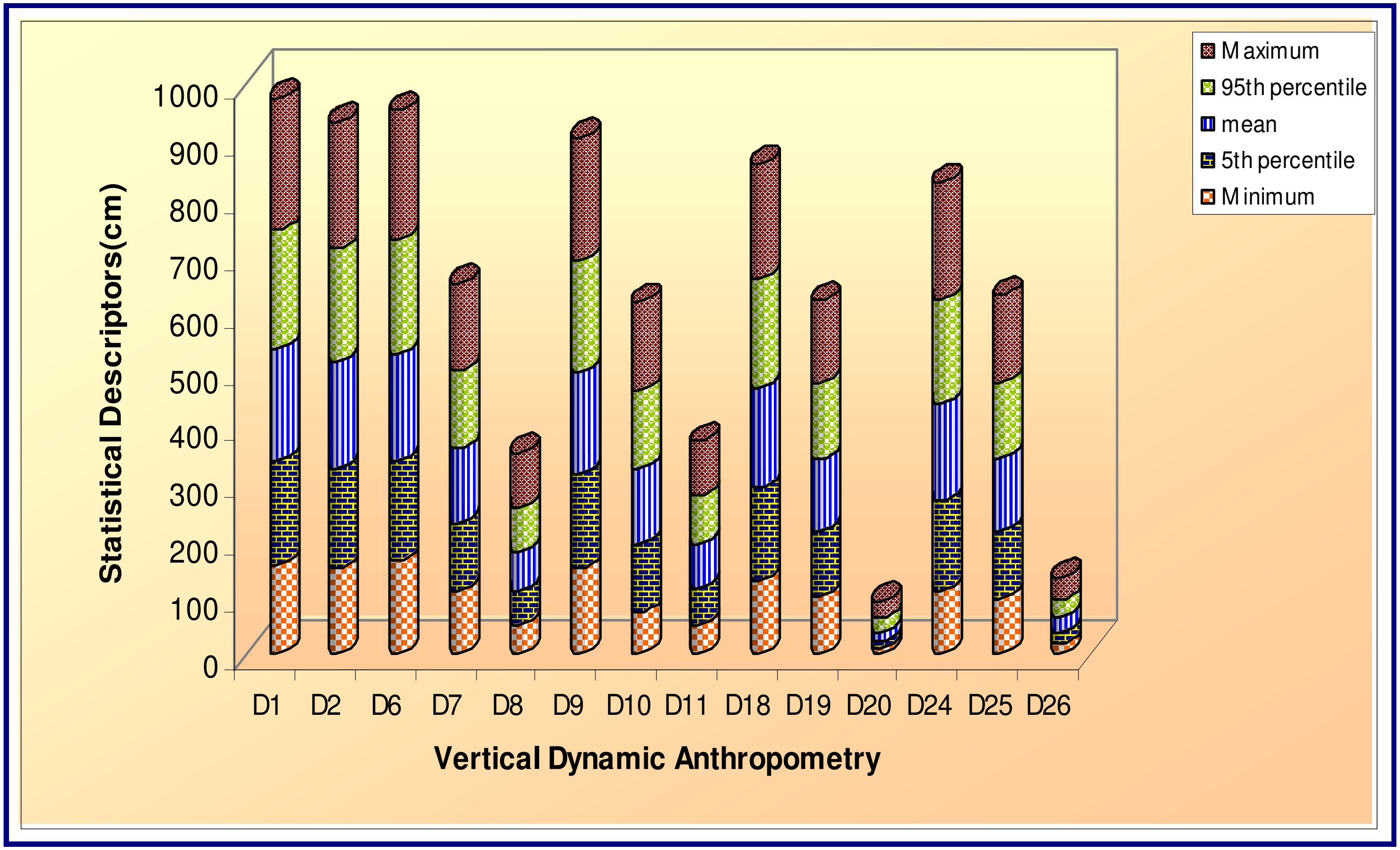


Figure 5: **Statistical descriptors of vertical dynamic anthropometry of selected women**

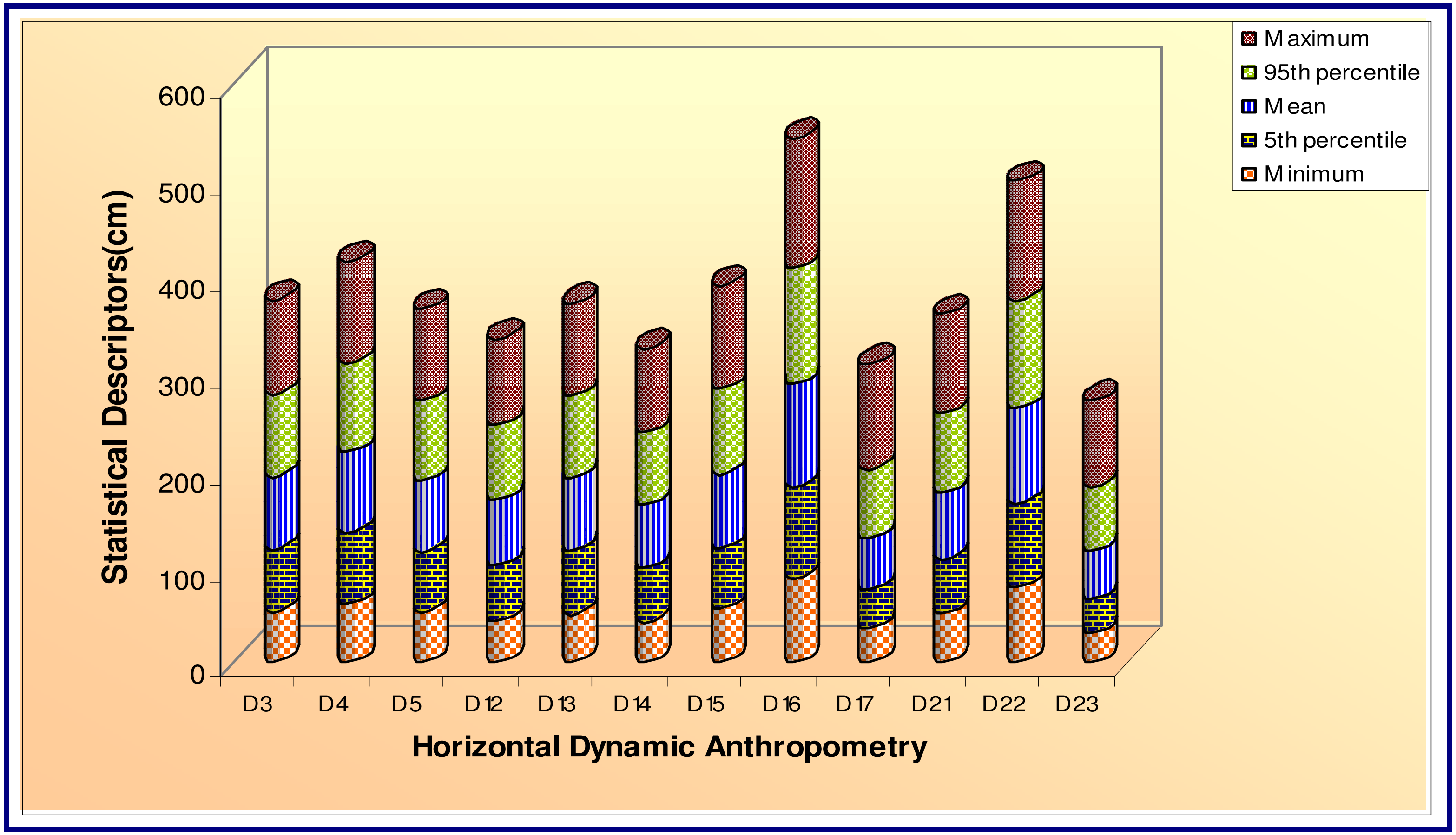


Figure 6: **Statistical descriptors of horizontal dynamic anthropometry of selected women**

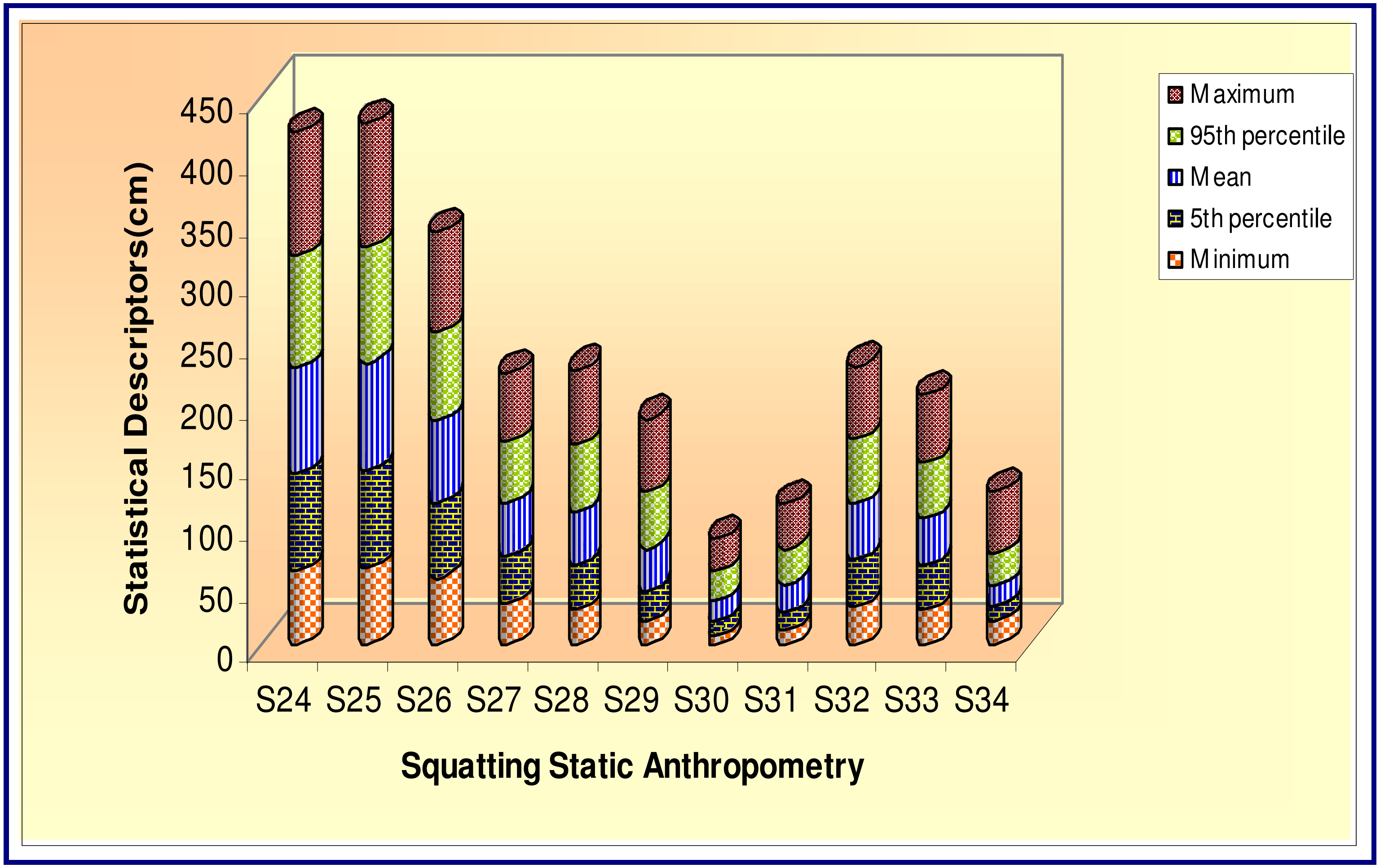


Figure 7: **Statistical descriptors of squatting static anthropometry of selected women**

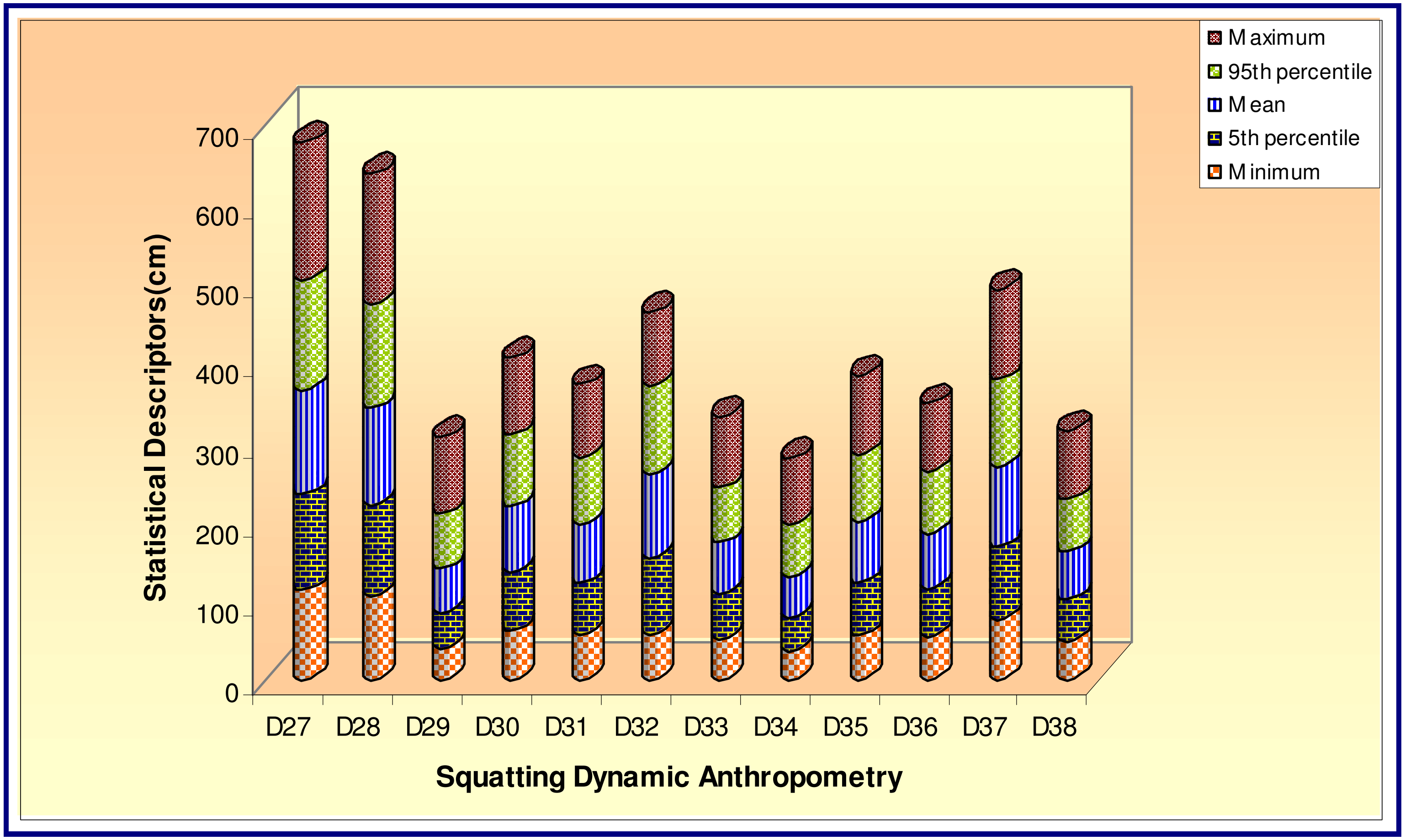


Figure 8: **Statistical descriptors of squatting dynamic anthropometry of selected women**

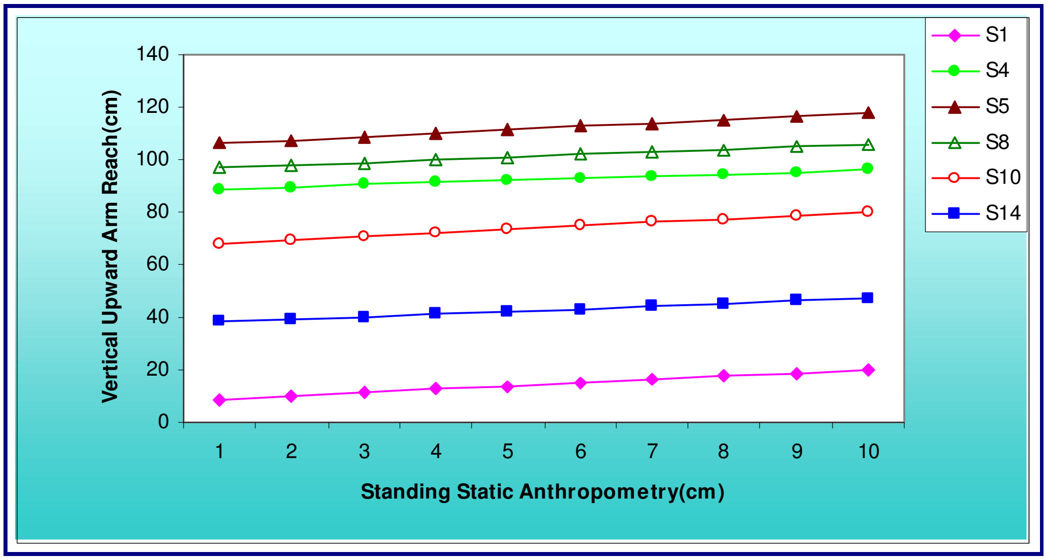


Figure 9 : **Regression analysis between standing static anthropometry and Vertical Upward Arm Reach (D_1) of women**

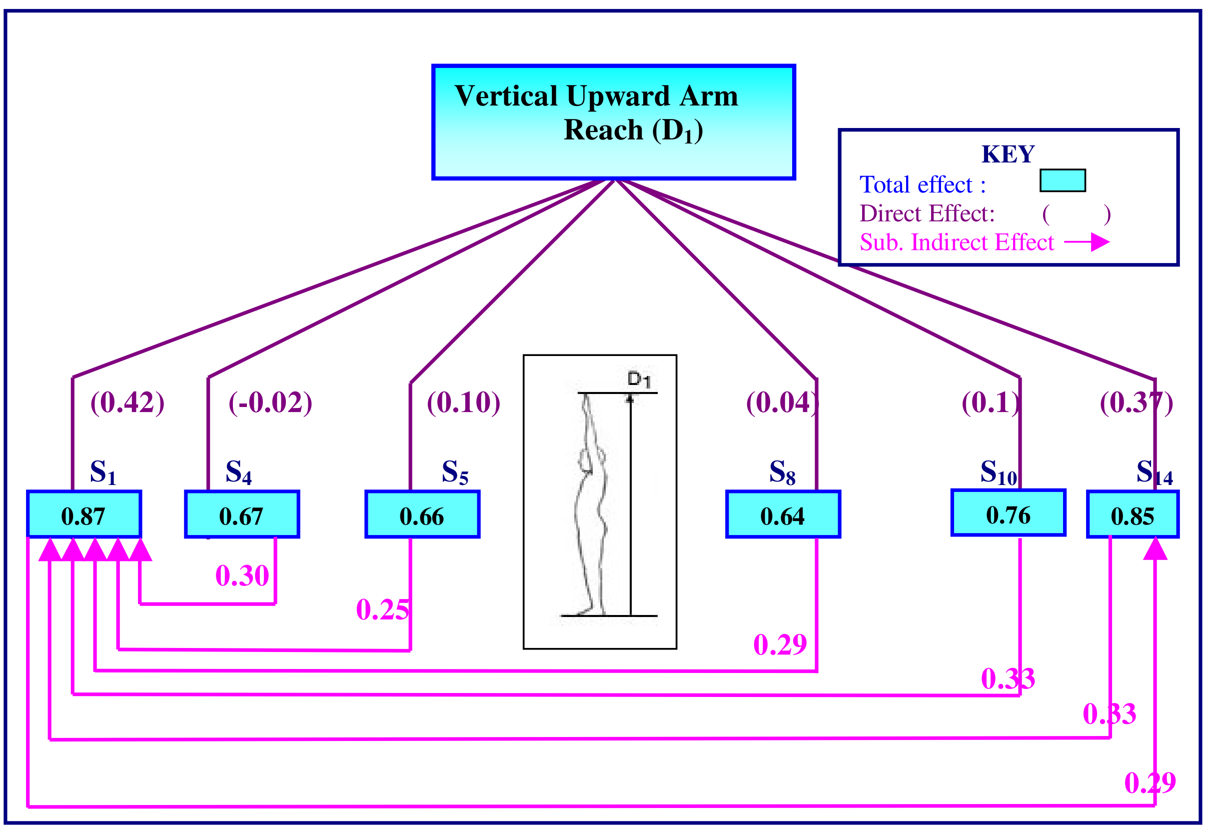


Figure 10: **Path analysis between standing static anthropometry and Vertical Upward Arm Reach (D_1) of women**

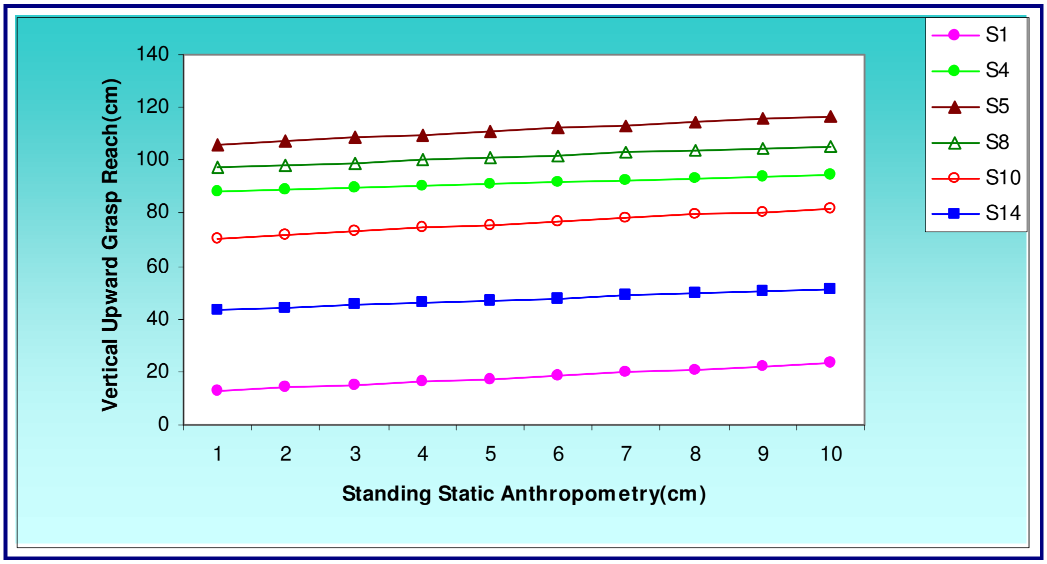


Figure 11: **Regression analysis between standing static anthropometry and Vertical Upward Grasp Reach (D_2) of women**

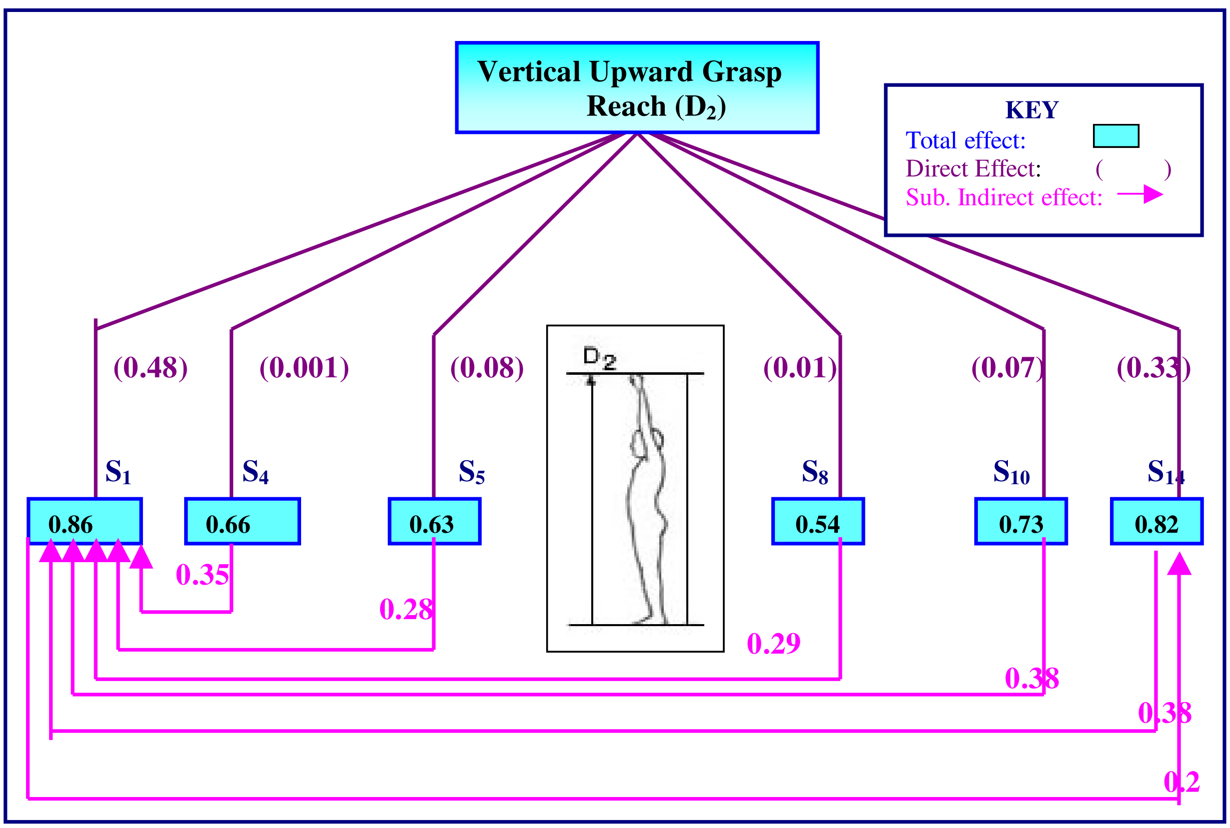


Figure 12: **Path analysis between standing static anthropometry and Vertical Upward Grasp Reach (D_2) of women**

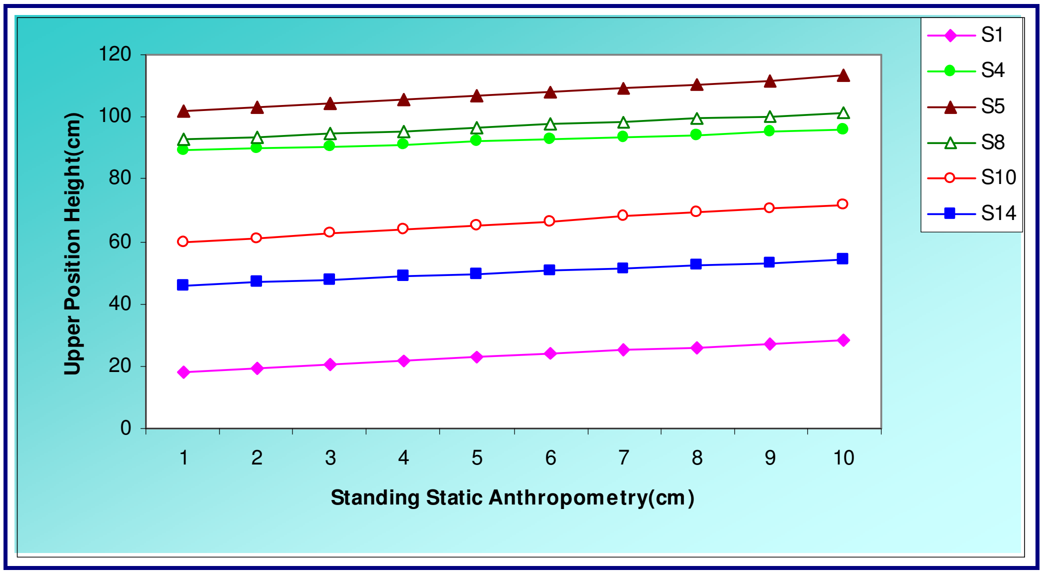


Figure 13: **Regression analysis between standing static anthropometry and Upper Position Arm Reach Height (D_6) of women**

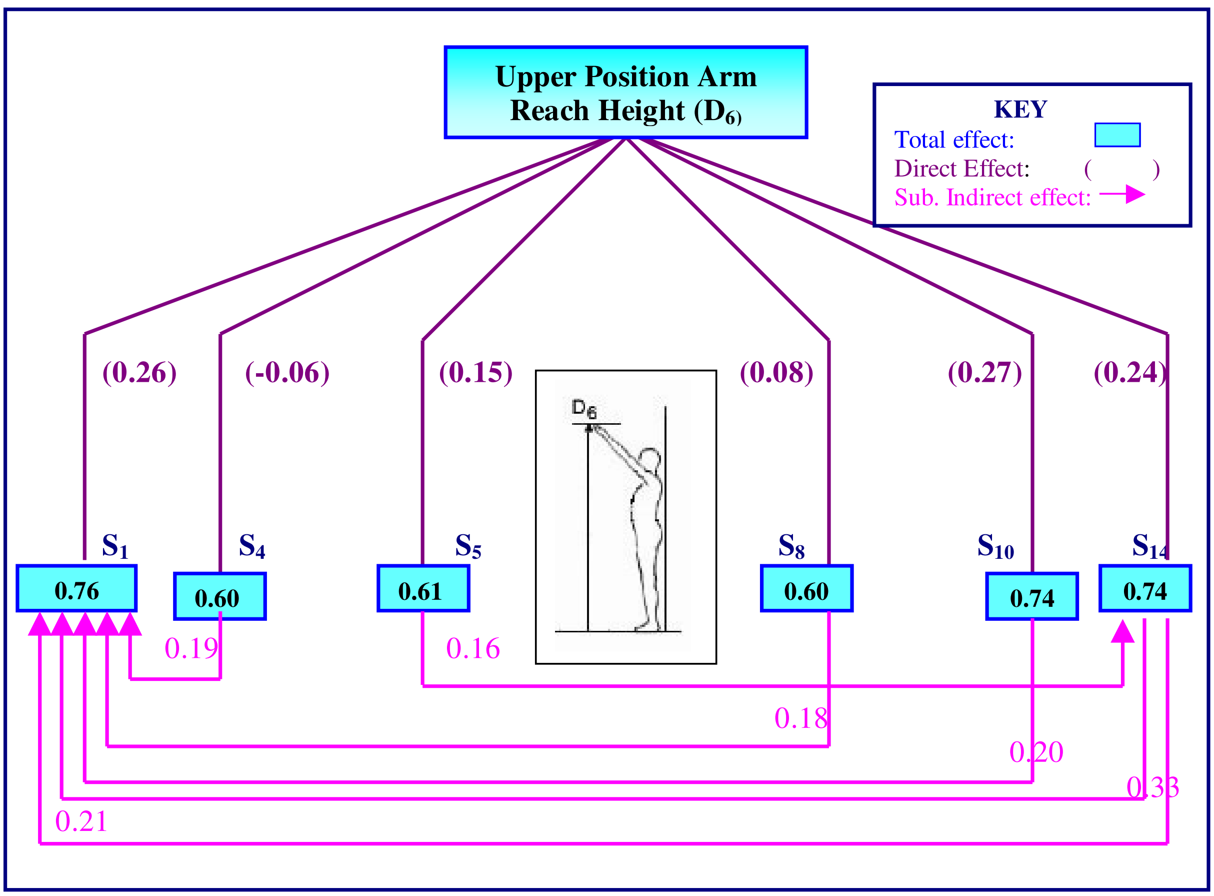


Figure 14: **Path analysis between standing static anthropometry and Upper Position Arm Reach Height (D_6) of women**

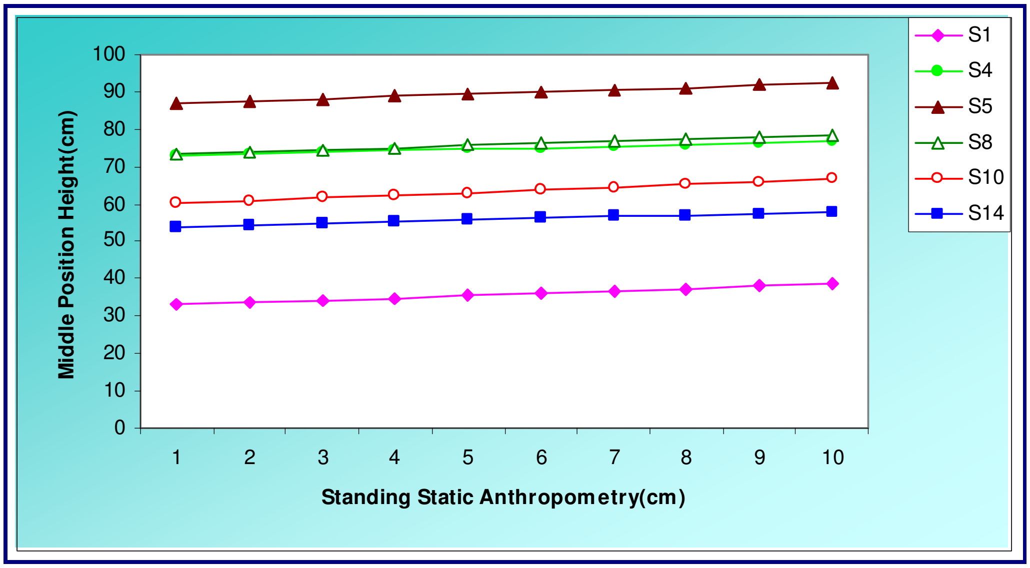


Figure 15: Regression analysis between standing static anthropometry and Middle Position Arm Reach Height (D_7) of women

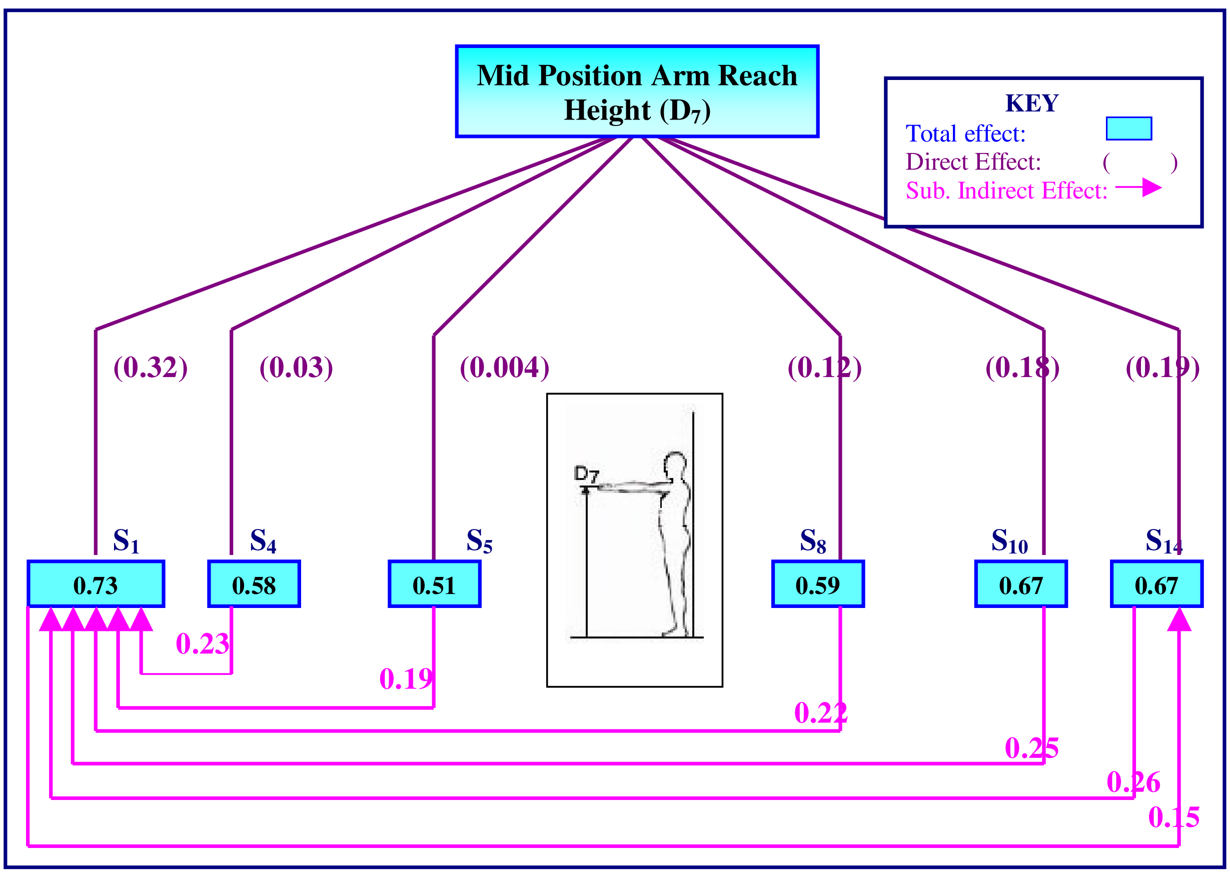


Figure 16: Path analysis between standing static anthropometry and Mid position Arm Reach Height (D_7) of women

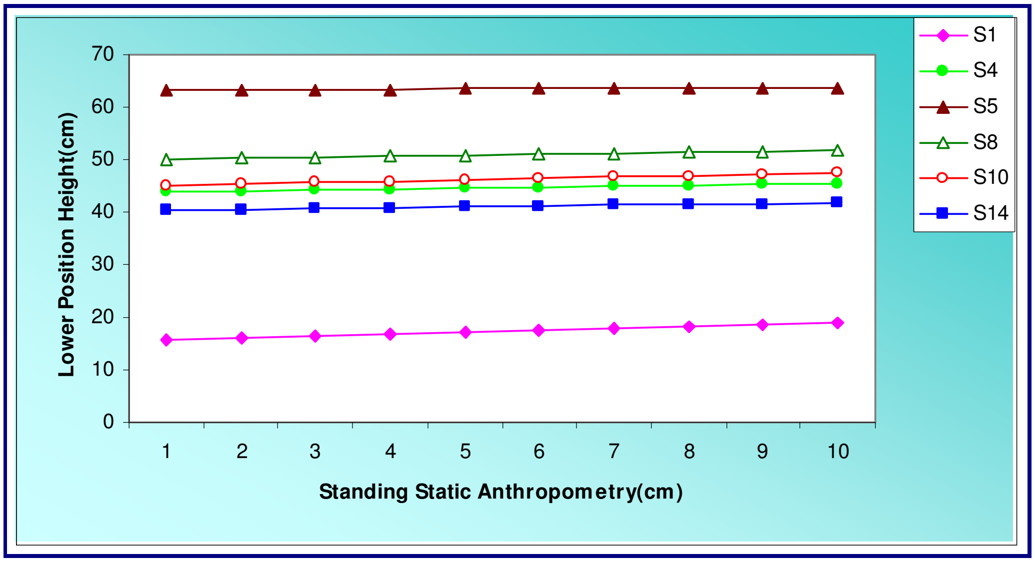


Figure 17: **Regression analysis between standing static anthropometry and Lower Position Arm Reach Height (D_8) of women**

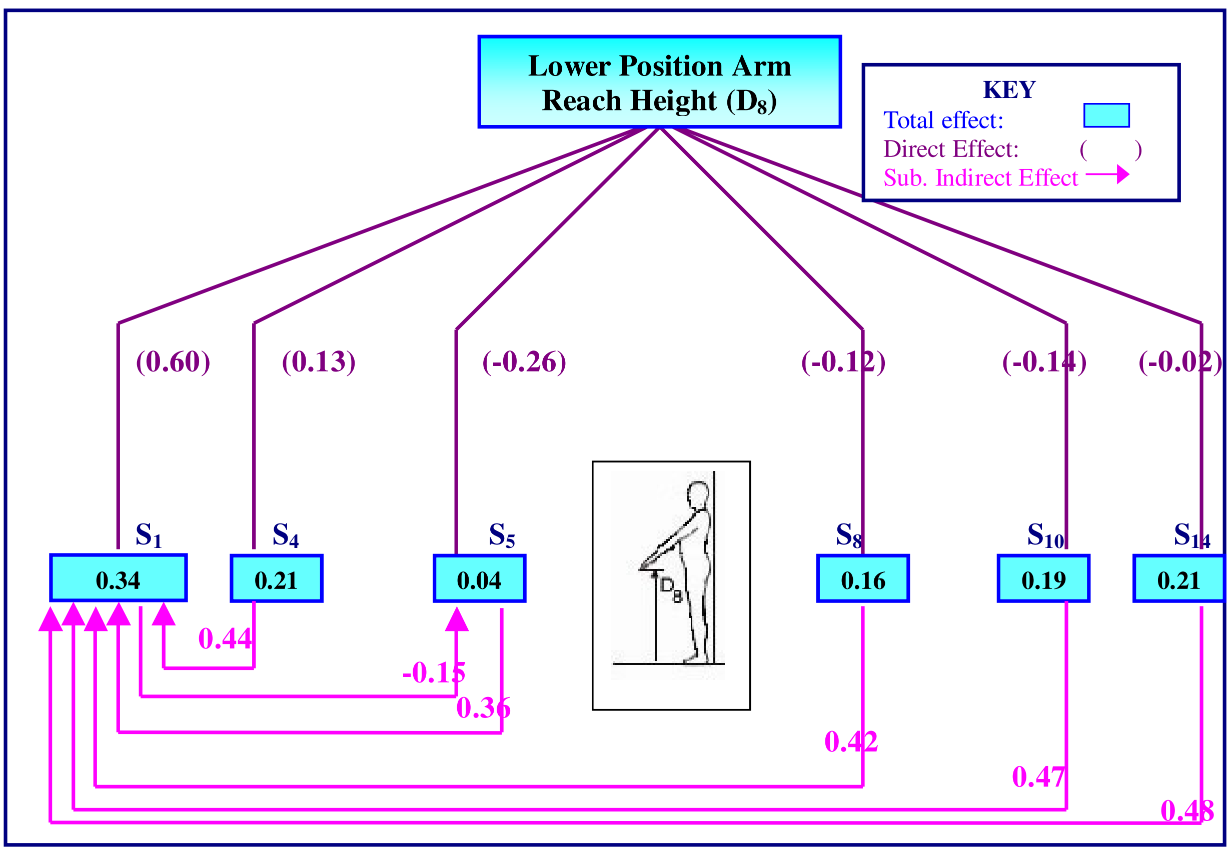


Figure 18: **Path analysis between standing static anthropometry and Lower Position Arm Reach Height (D_8) of women**

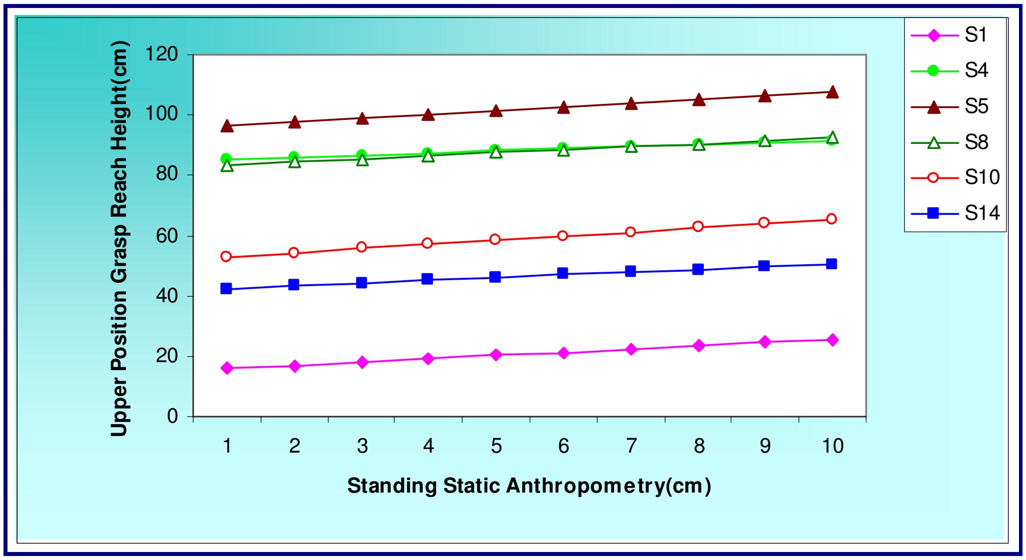


Figure 19: **Regression analysis between standing static anthropometry and Upper Position Grasp Reach Height (D_9) of women**

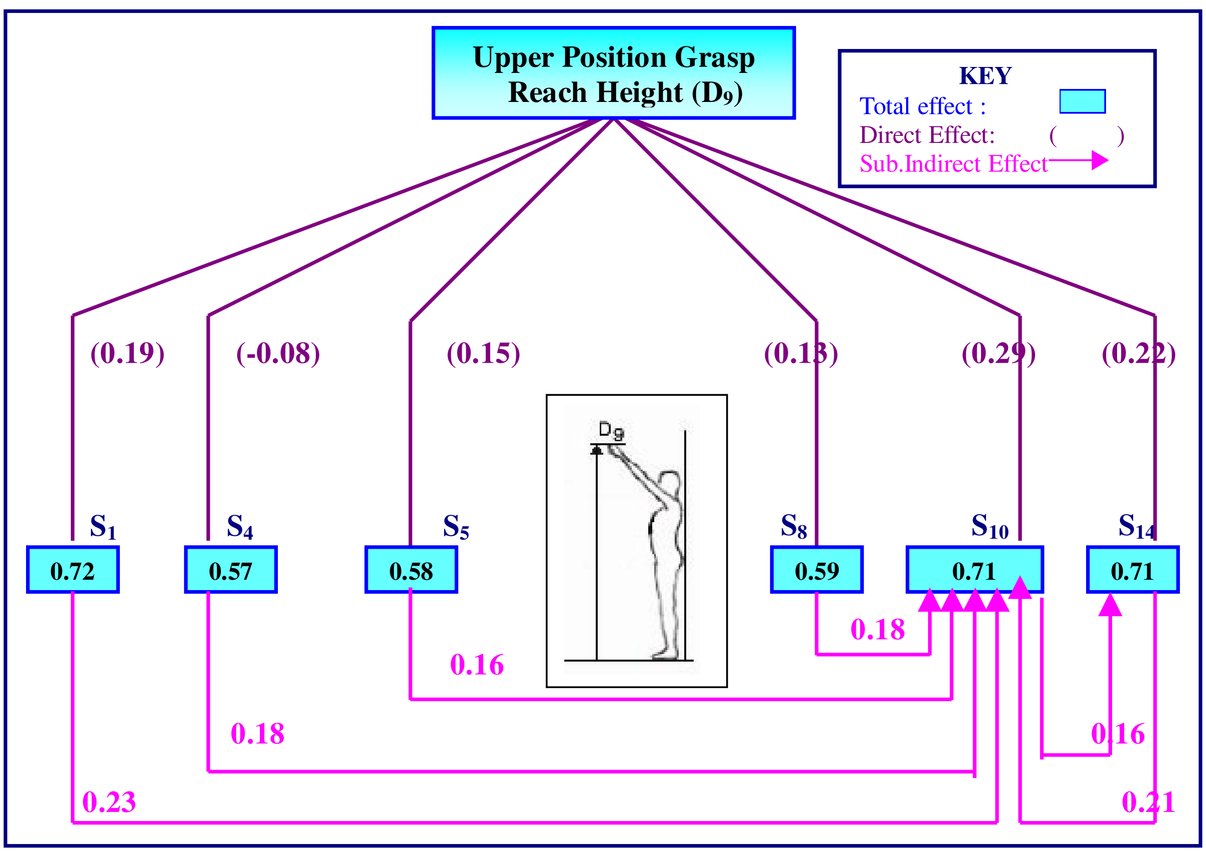


Figure 20: **Path analysis between standing static anthropometry and Upper Position Grasp Reach Height (D_9) of women**

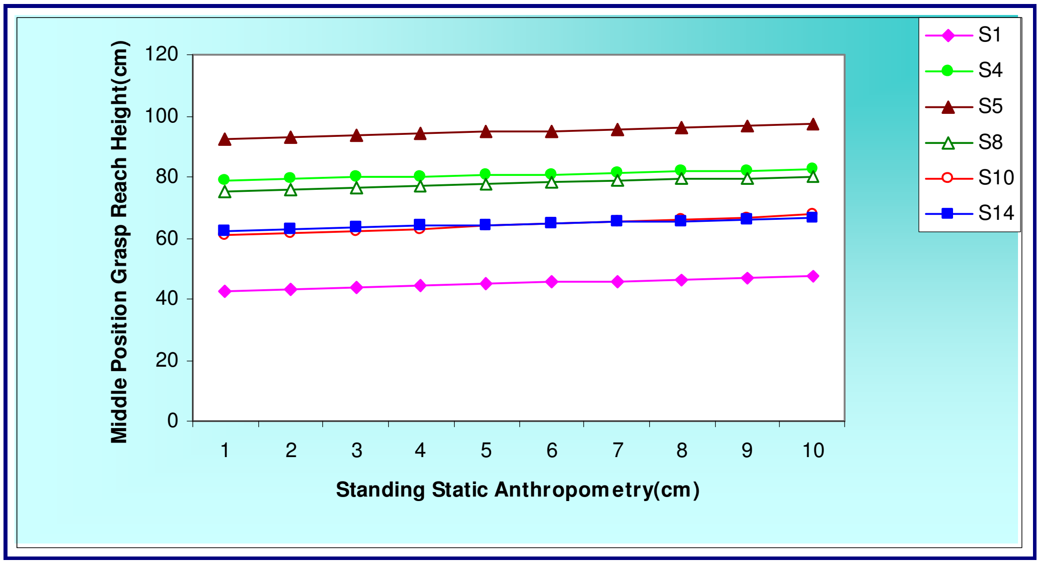


Figure 21: Regression analysis between standing static anthropometry and Mid Position Grasp Reach Height (D_{10}) of women

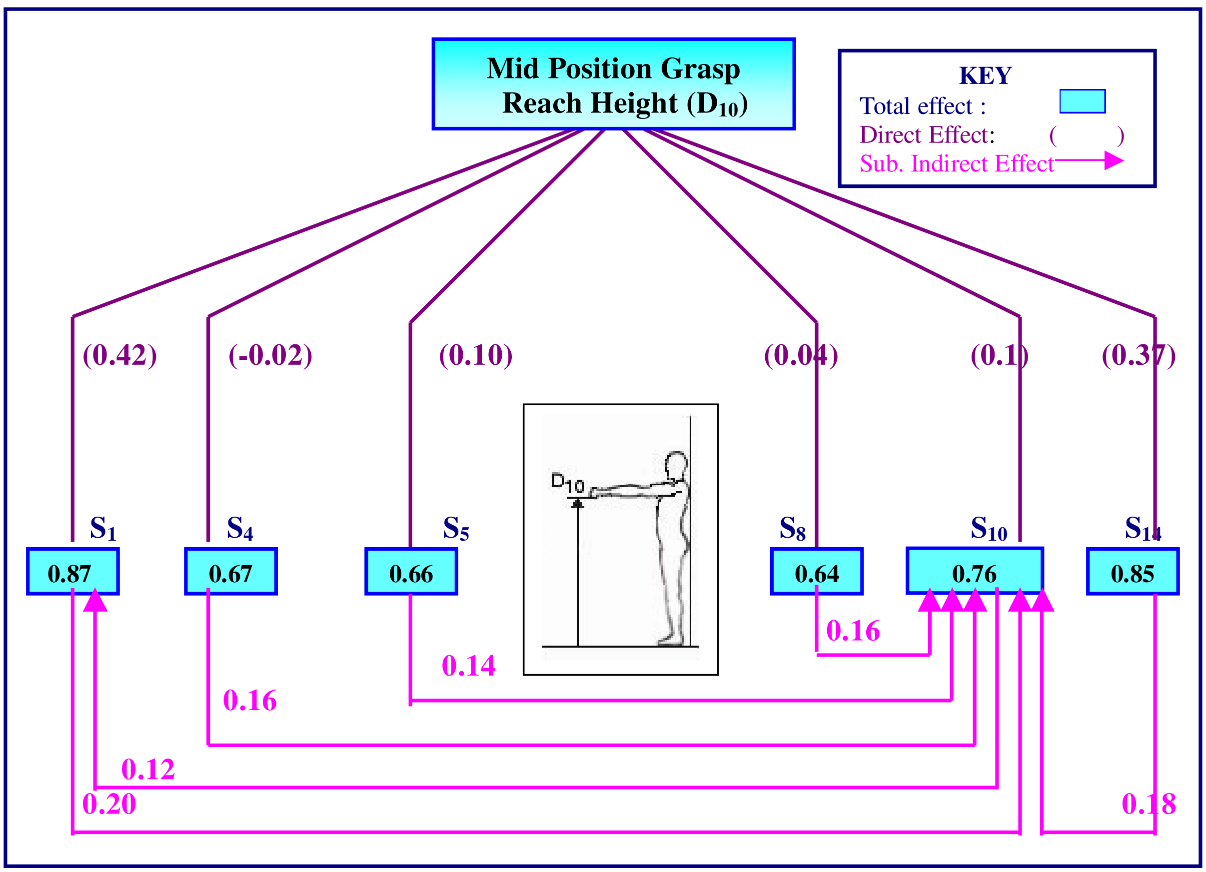


Figure 22: Path analysis between standing static anthropometry and Mid position Grasp Reach Height (D_{10}) of women

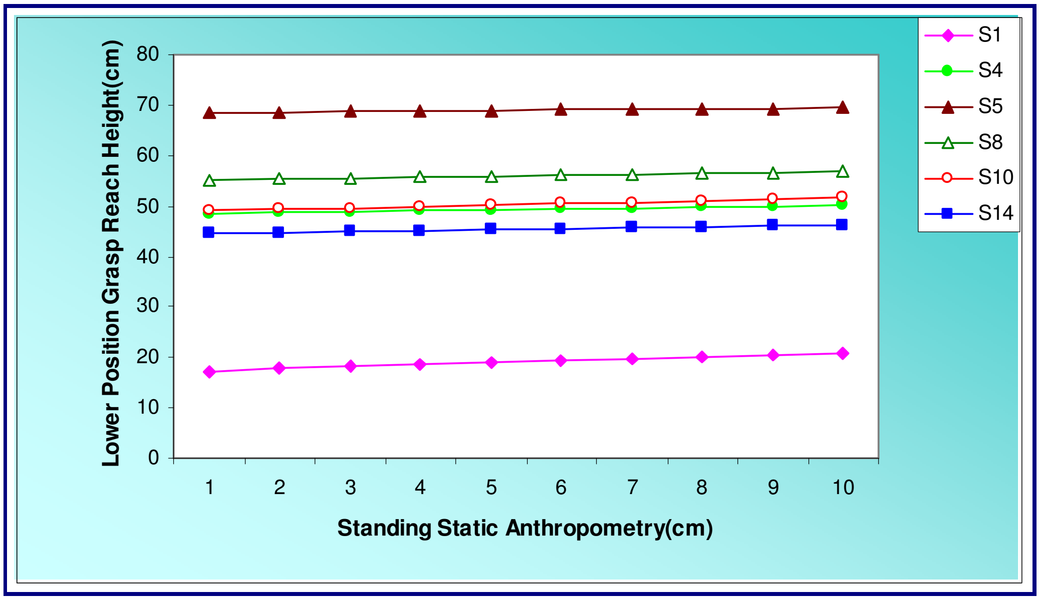


Figure 23: **Regression analysis between standing static anthropometry and Lower Position Grasp Reach Height (D_{11}) of women**

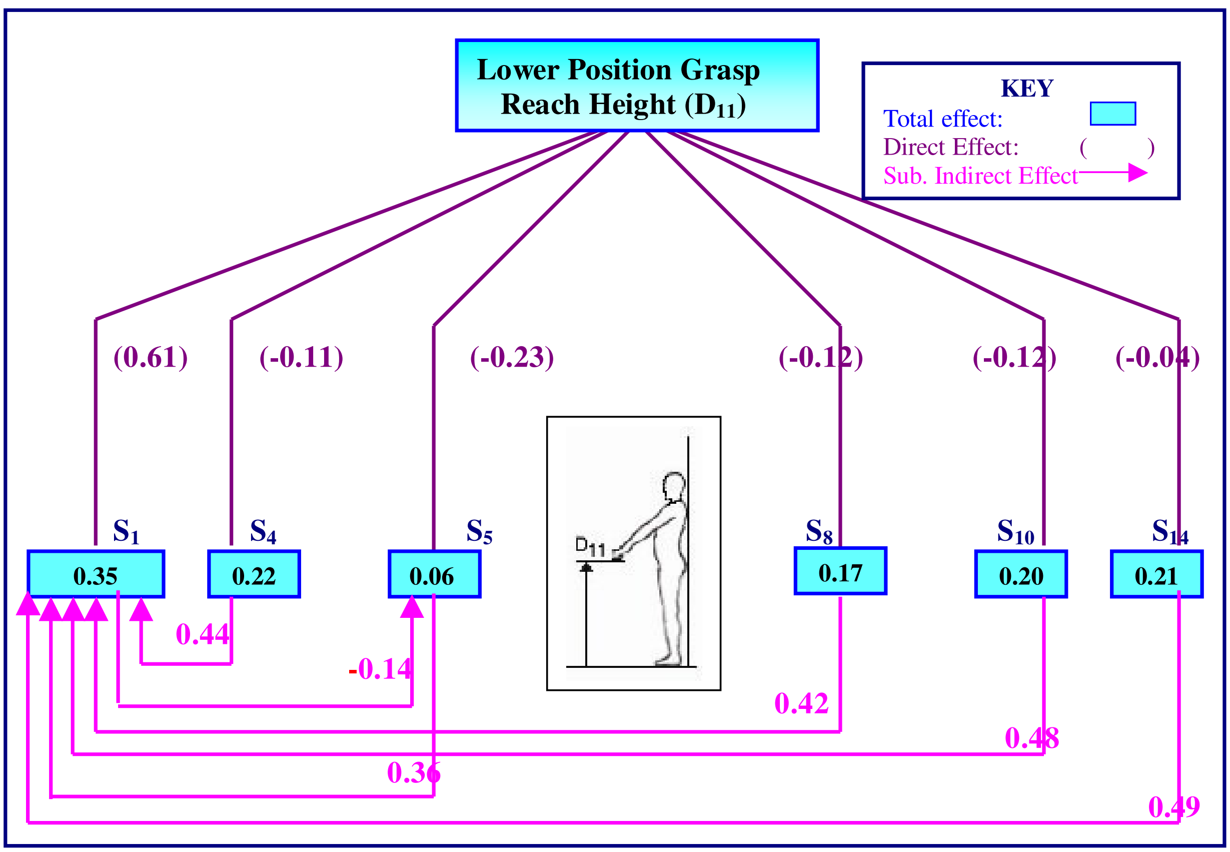


Figure 24: **Path analysis between standing static anthropometry and Lower Position Grasp Reach Height (D_{11}) of women**

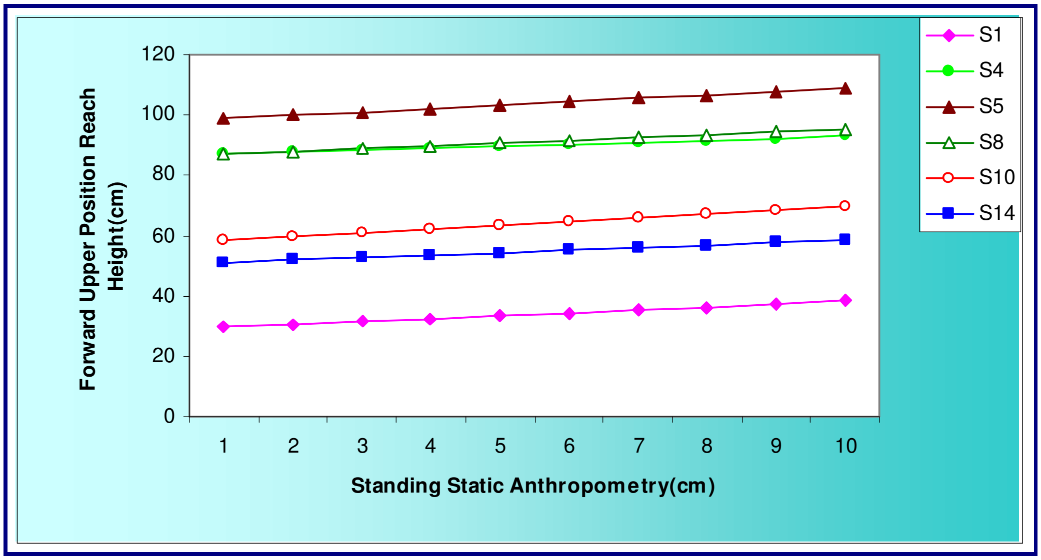


Figure 25: Regression analysis between standing static anthropometry and Forward Upper Position Reach Height (D_{18}) of women

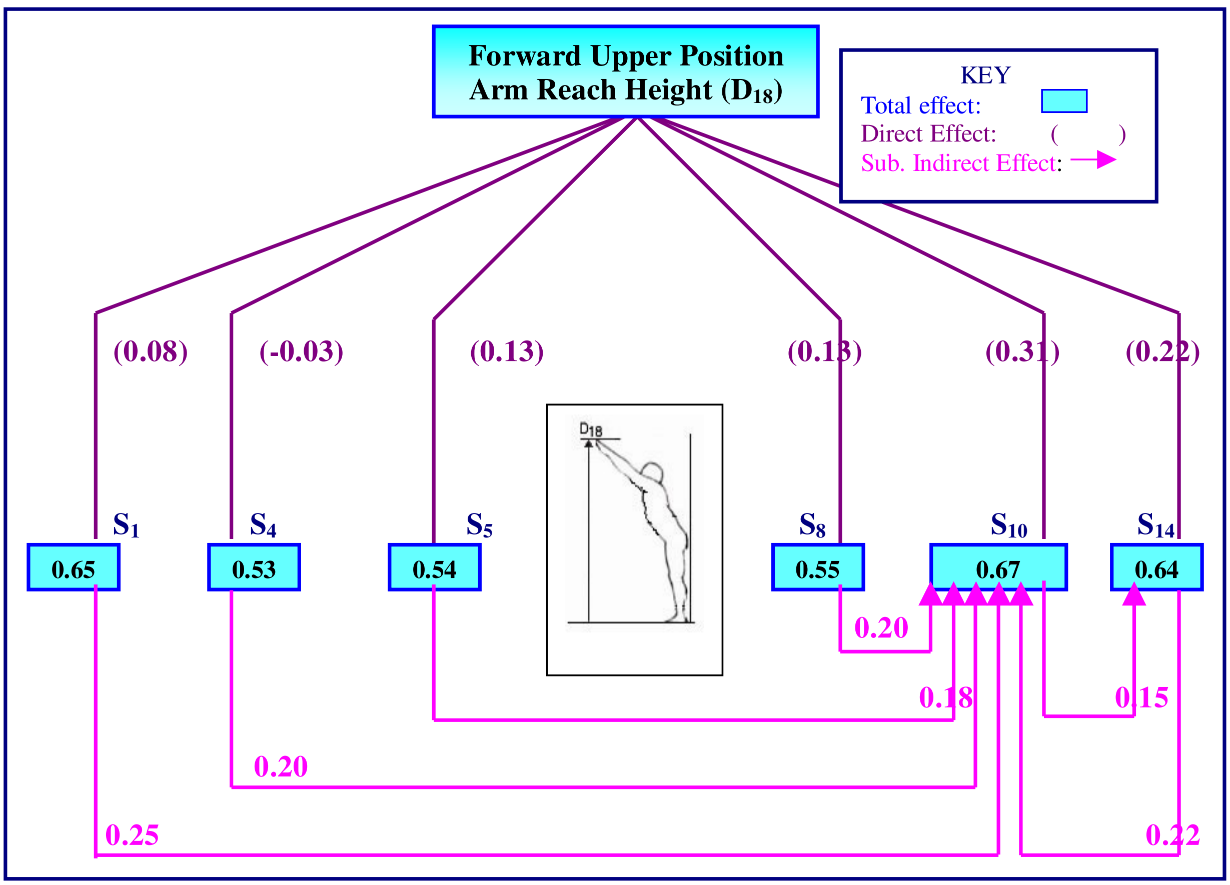


Figure 26: Path analysis between standing static anthropometry and Forward Upper Position Arm Reach Height (D_{18}) of women

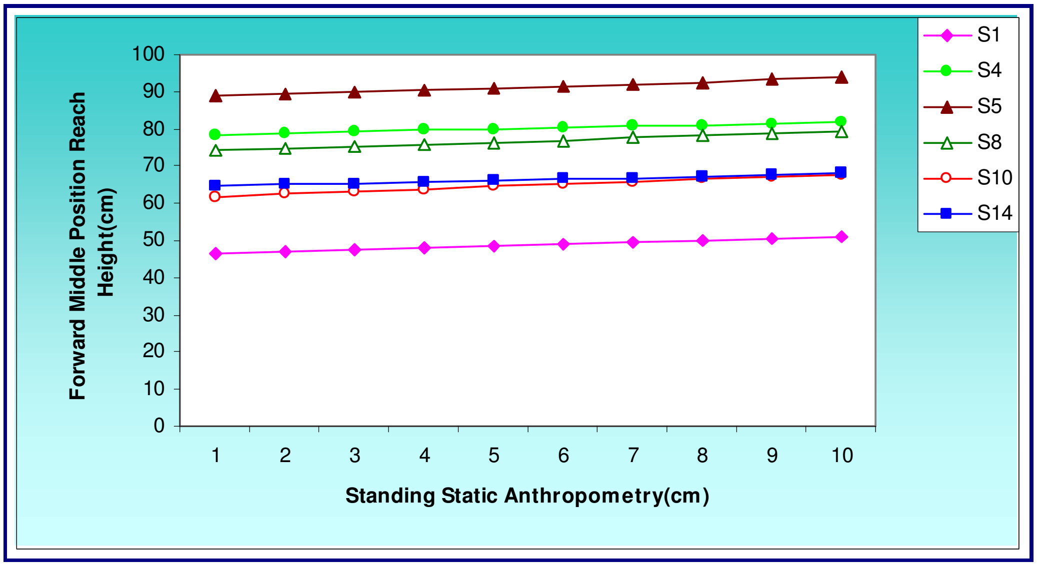


Figure 27: Regression analysis between standing static anthropometry and Forward Mid Position Arm Reach Height (D_{19}) of women

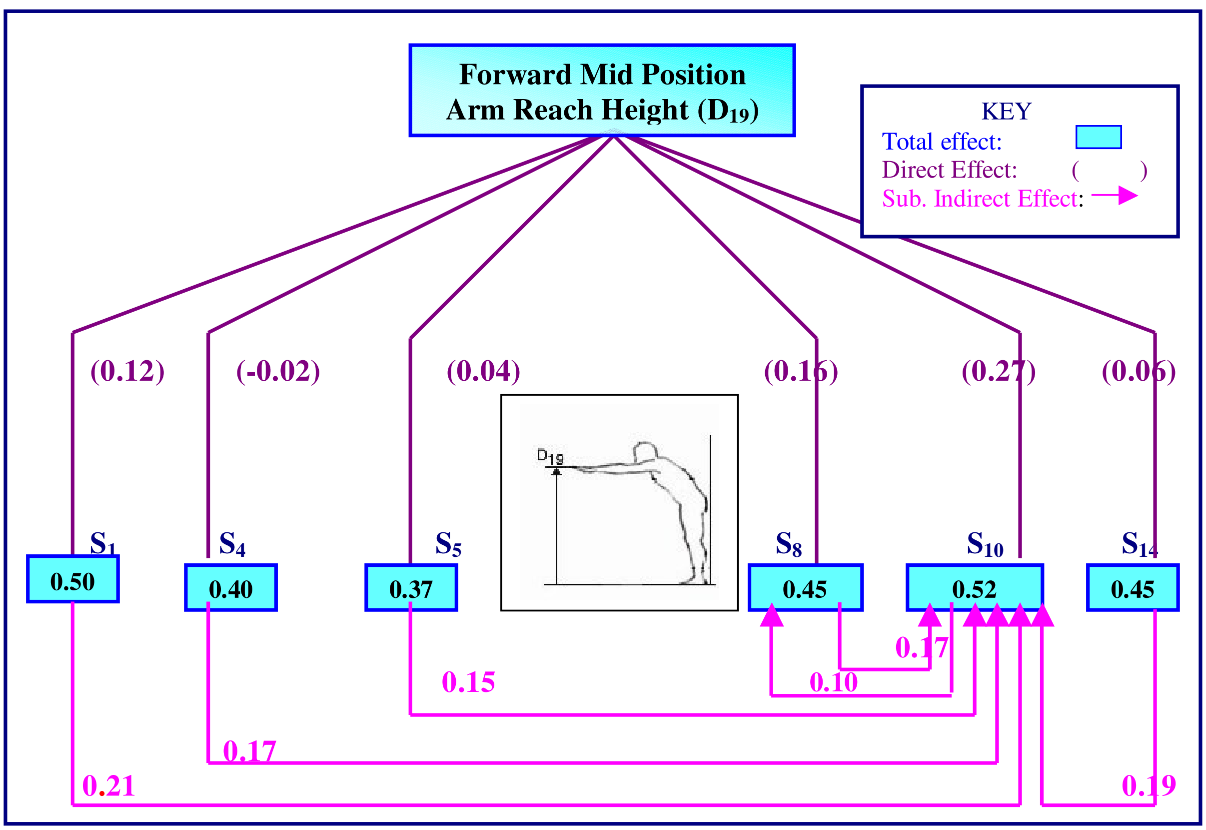


Figure 28: Path analysis between standing static anthropometry and Forward Mid Position Reach Height (D_{19}) of women

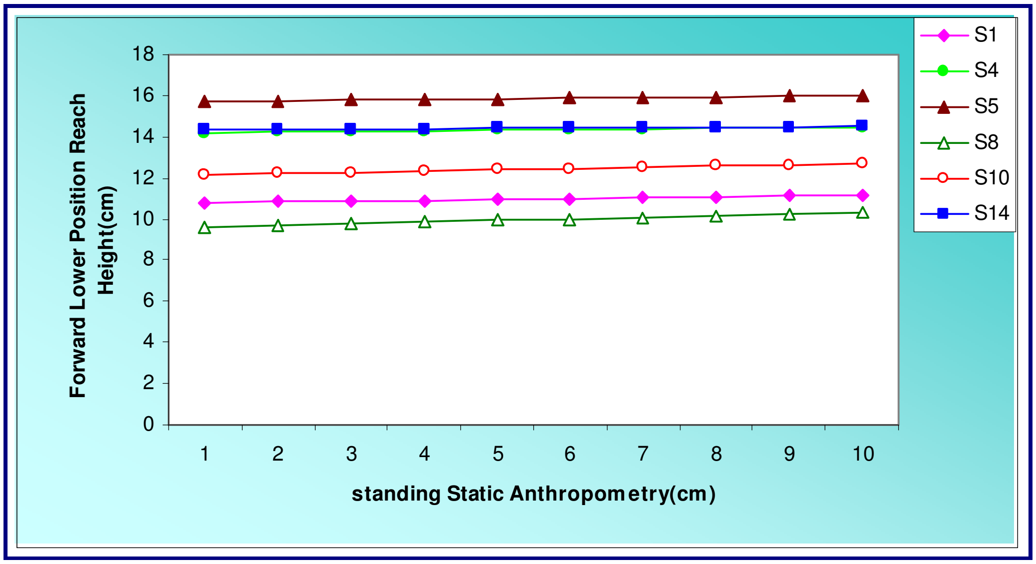


Figure 29: Regression analysis between standing static anthropometry and Forward Lower Position Arm Reach Height (D_{20}) of women

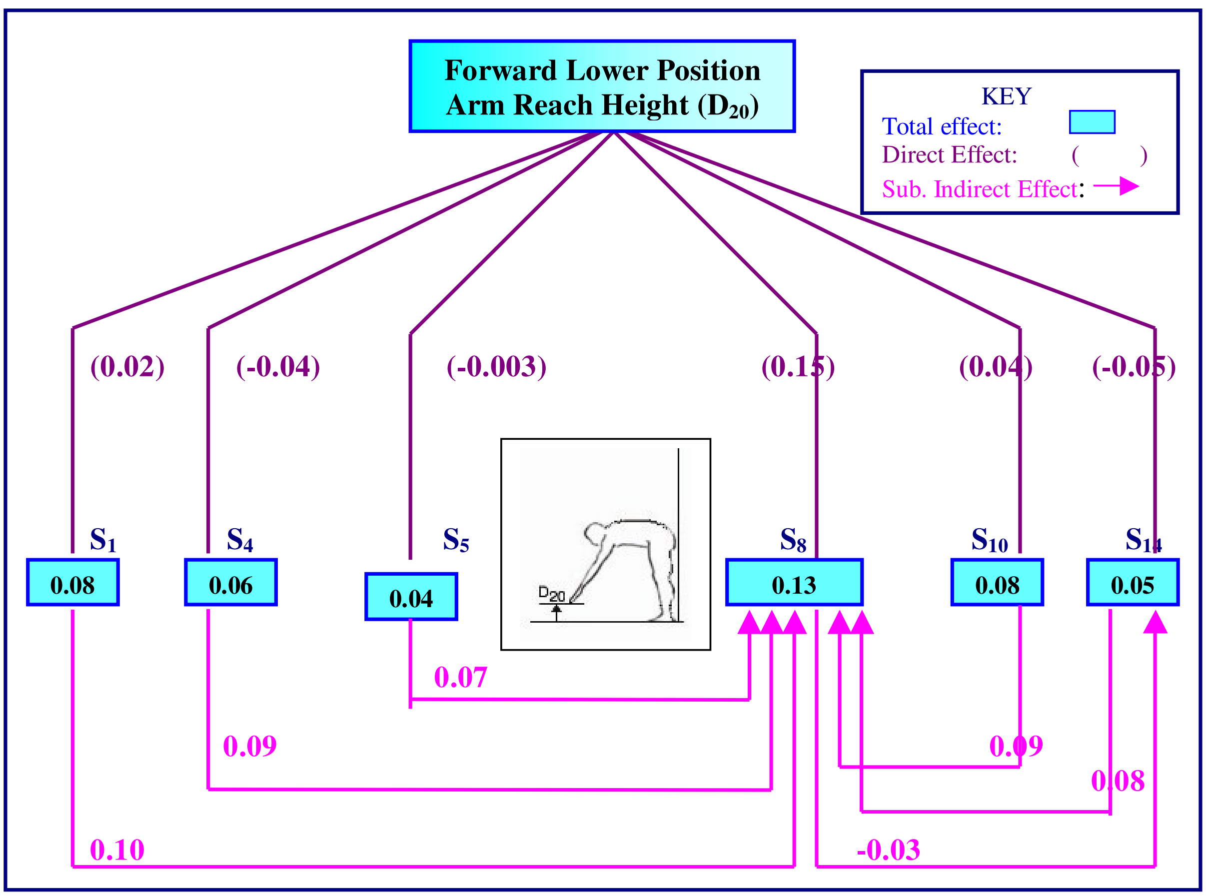


Figure 30: Path analysis between standing static anthropometry and Forward Lower Position Arm Reach Height (D_{20}) of women

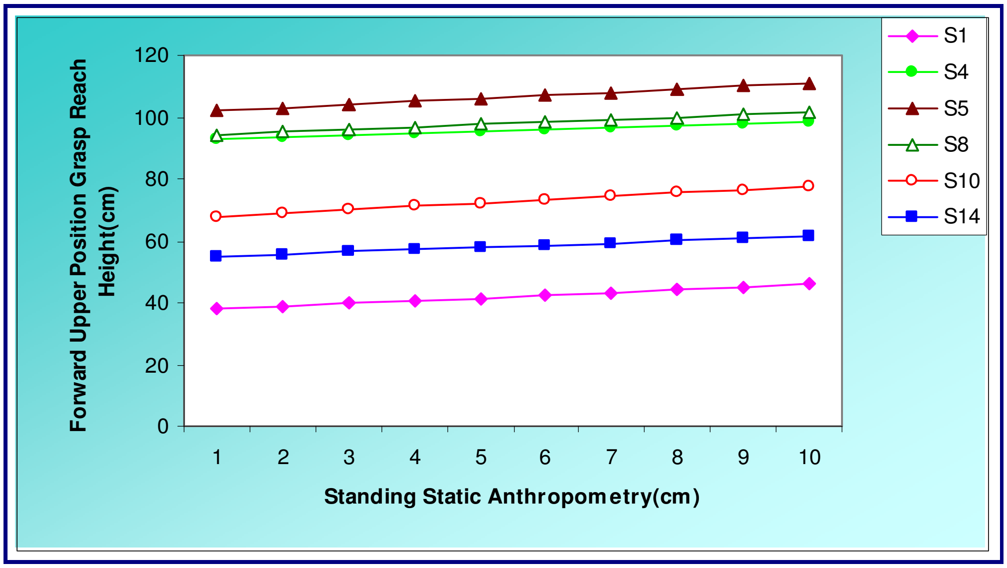


Figure 31: Regression analysis between standing static anthropometry and Forward Upper Position Grasp Reach Height (D_{24}) of women

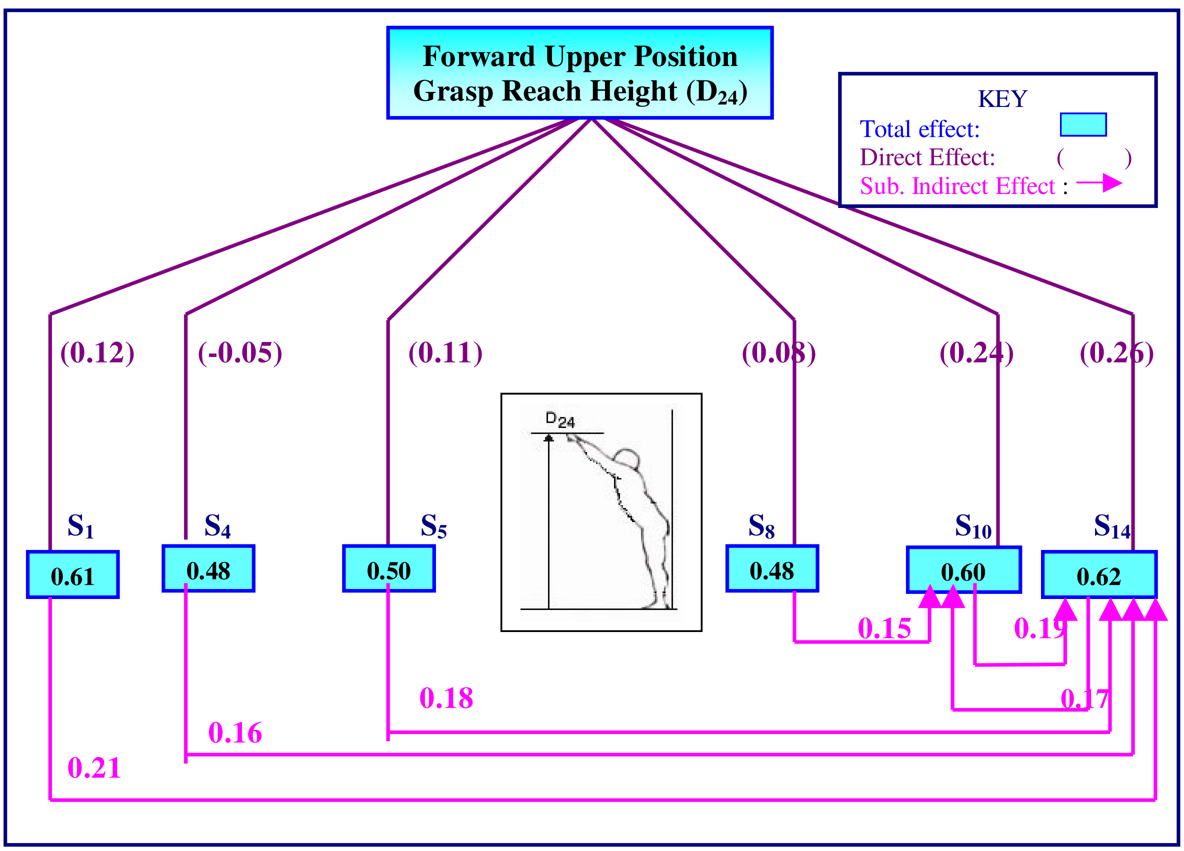


Figure 32: Path analysis between standing static anthropometry and Forward Upper Position Grasp Reach Height (D_{24}) of women

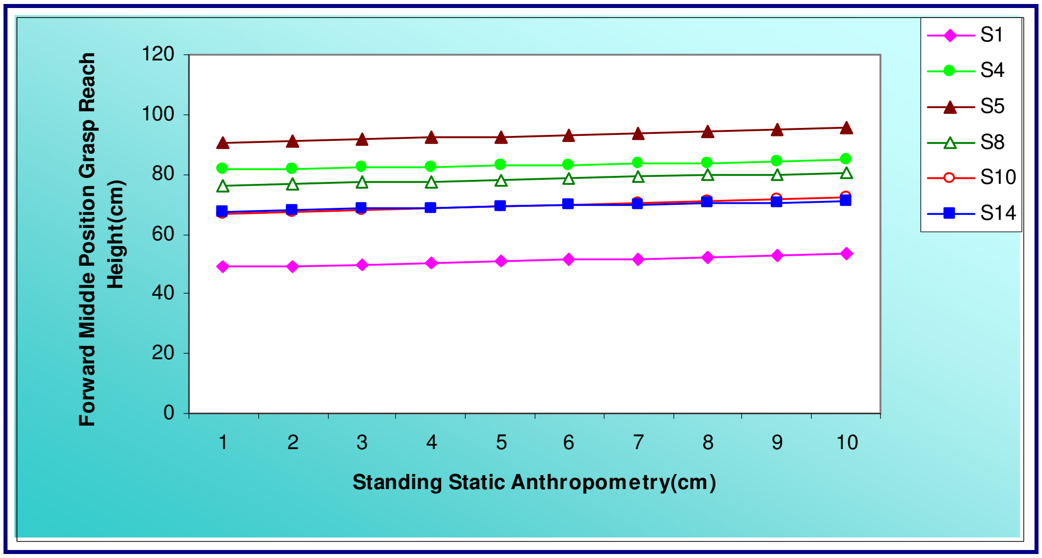


Figure 33: **Regression analysis between standing static anthropometry and Forward Mid Position Grasp Reach Height (D_{25}) of women**

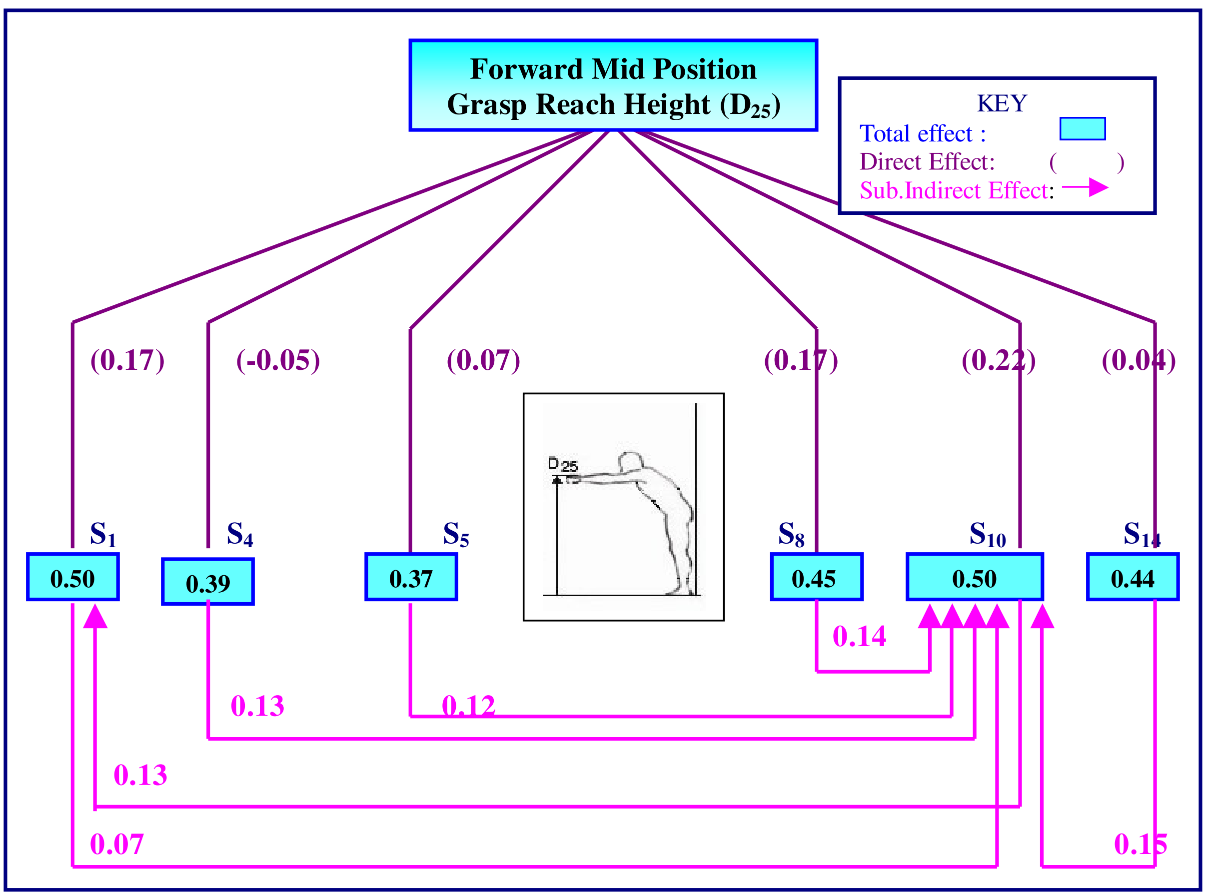


Figure 34: **Path analysis between standing static anthropometry and Forward Mid Position Grasp Reach Height (D_{25}) of women**

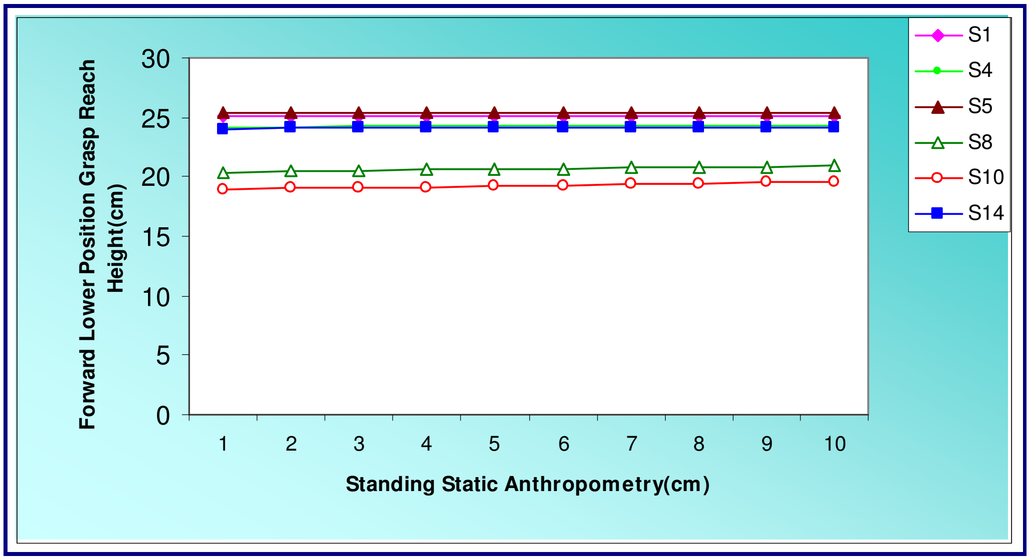


Figure 35: **Regression analysis between standing static anthropometry and Forward Lower Position Grasp Reach Height (D_{26}) of women**

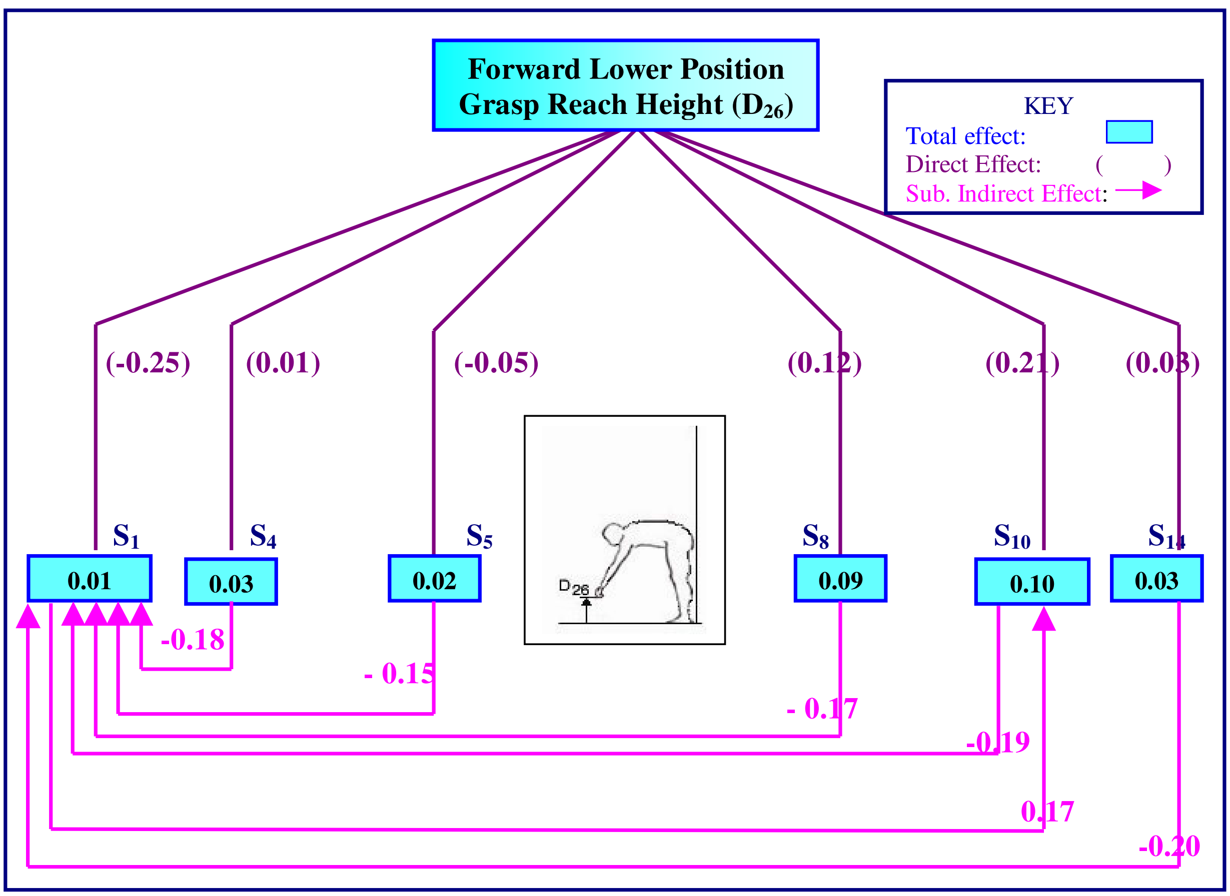


Figure 36: **Path analysis between standing static anthropometry and Forward Lower Position Grasp Reach Height (D_{26}) of women**

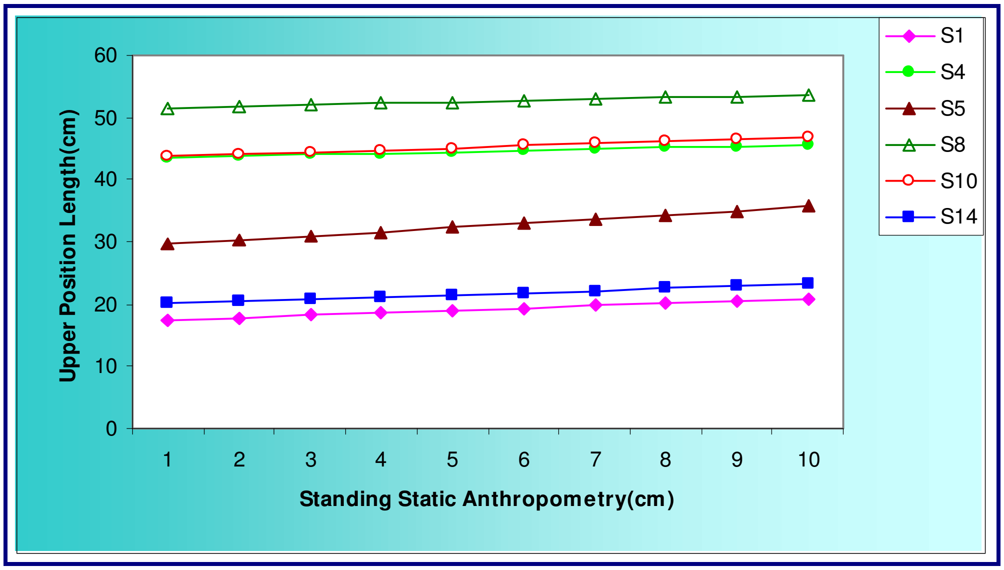


Figure 37: **Regression analysis between standing static anthropometry and Upper Position Arm Reach Length (D_3) of women**

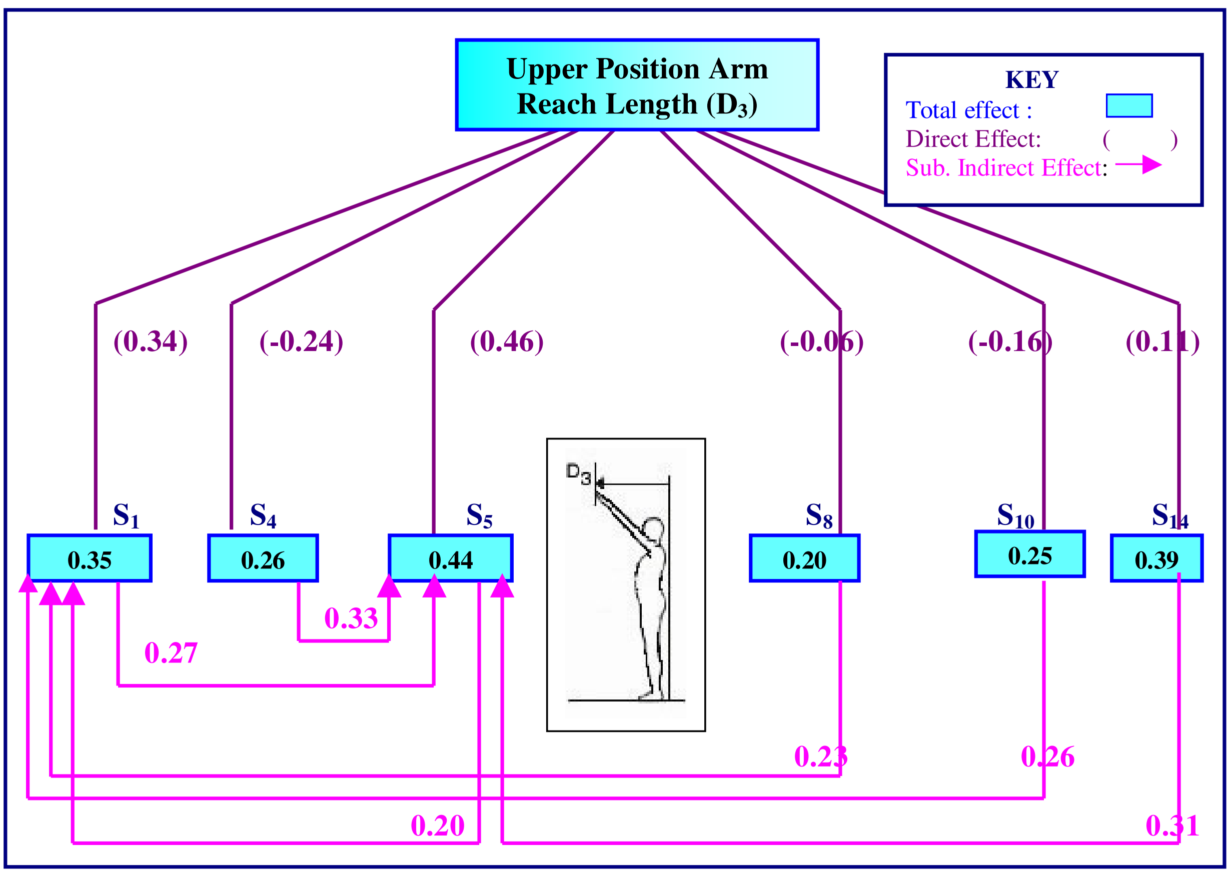


Figure 38: **Path analysis between standing static anthropometry and Upper Position Arm Reach Length (D_3) of women**

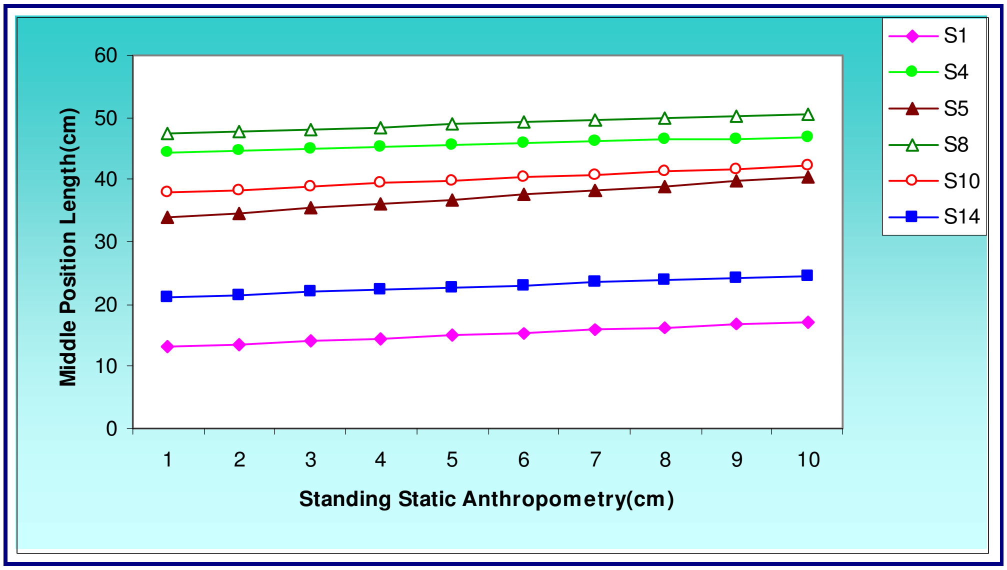


Figure 39: **Regression analysis between standing static anthropometry and Mid Position Arm Reach Length (D_4) of women**

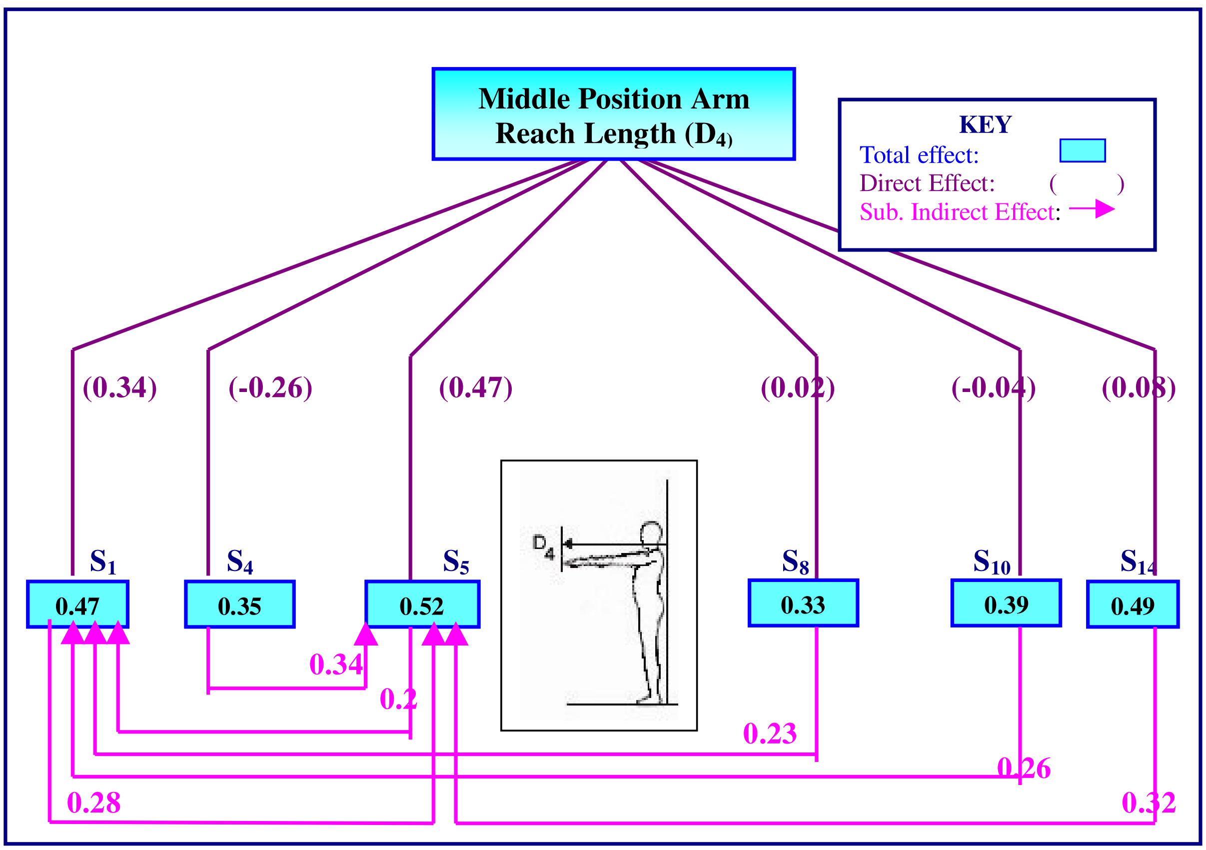


Figure 40: **Path analysis between standing static anthropometry and Mid position Arm Reach Length (D_4) of women**

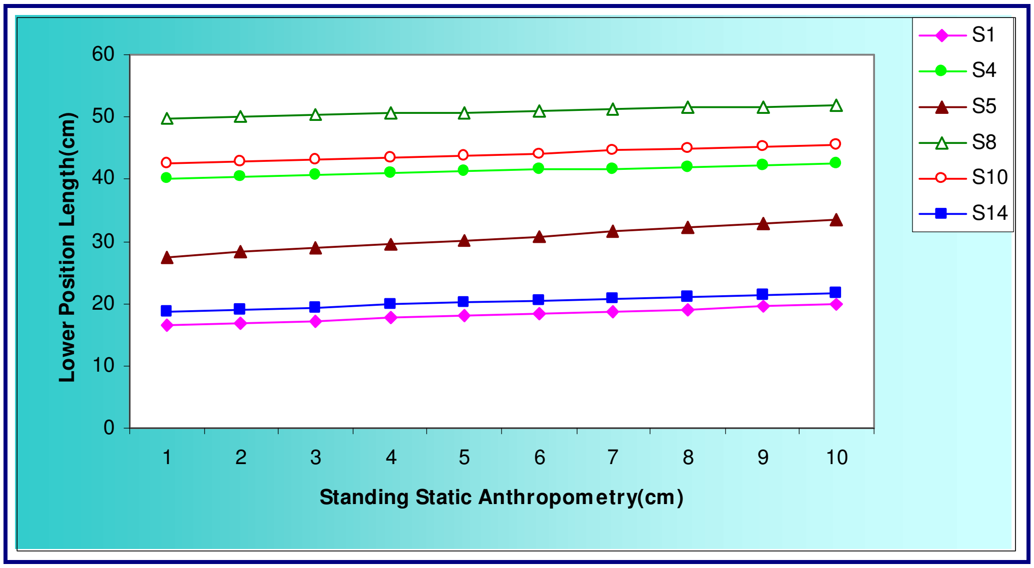


Figure 41: **Regression analysis between standing static anthropometry and Lower Position Arm Reach Length (D_5) of women**

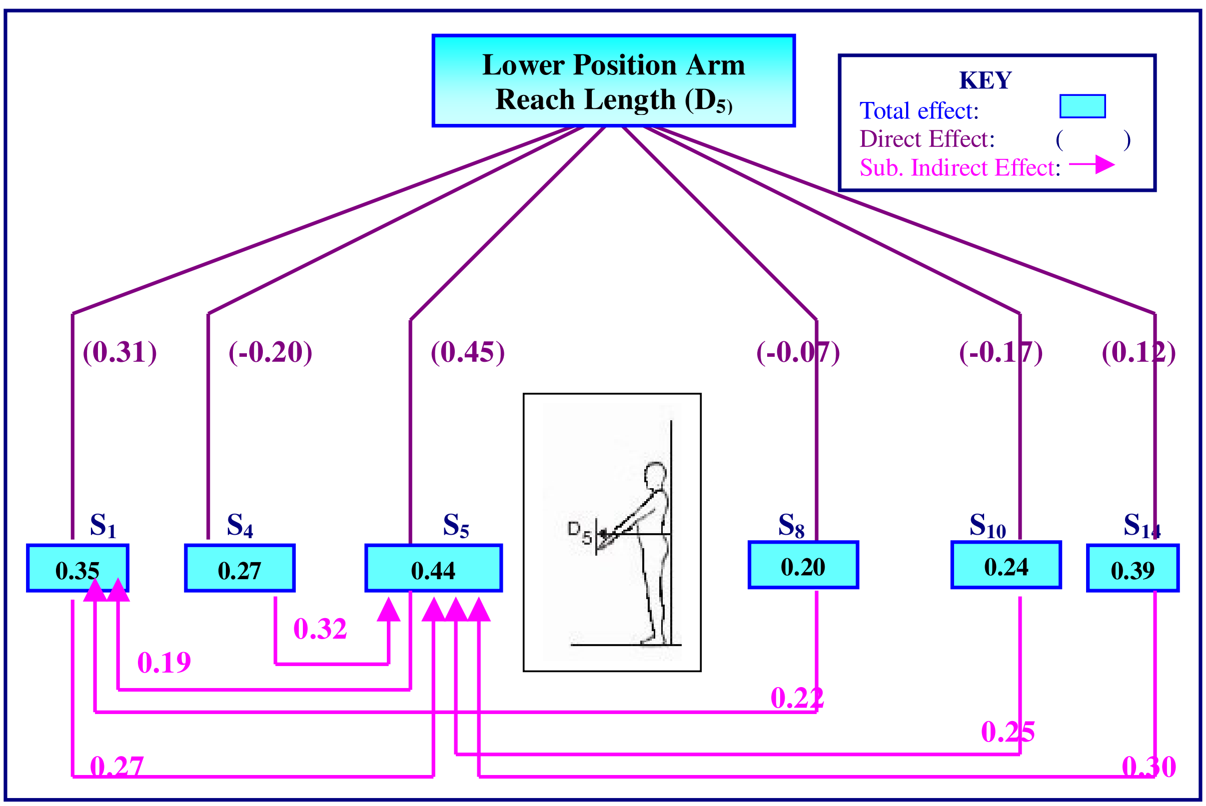


Figure 42: **Path analysis between standing static anthropometry and Lower Position Arm Reach Length (D_5) of women**

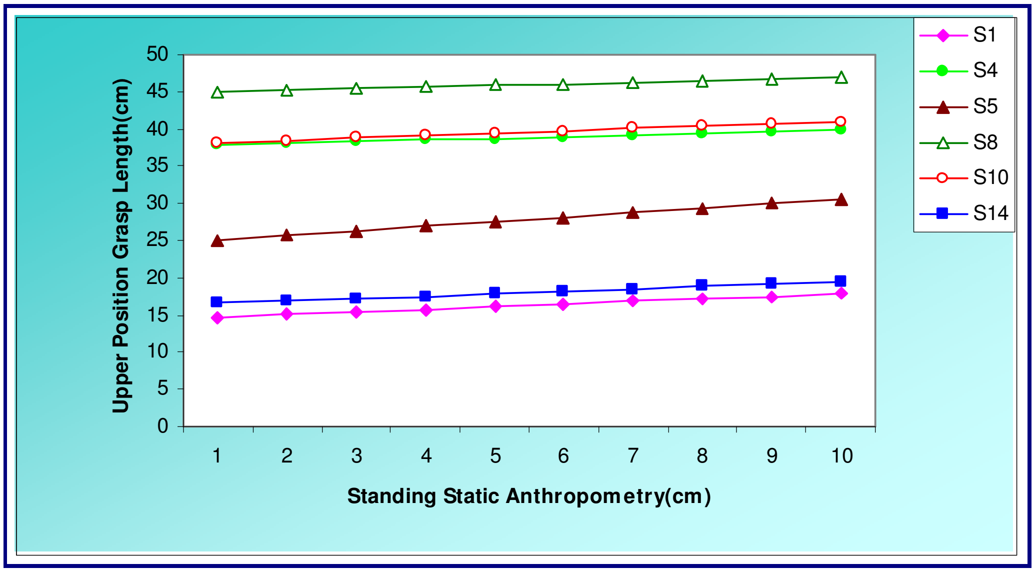


Figure 43: **Regression analysis between standing static anthropometry and Upper Position Grasp Reach Length (D_{12}) of women**

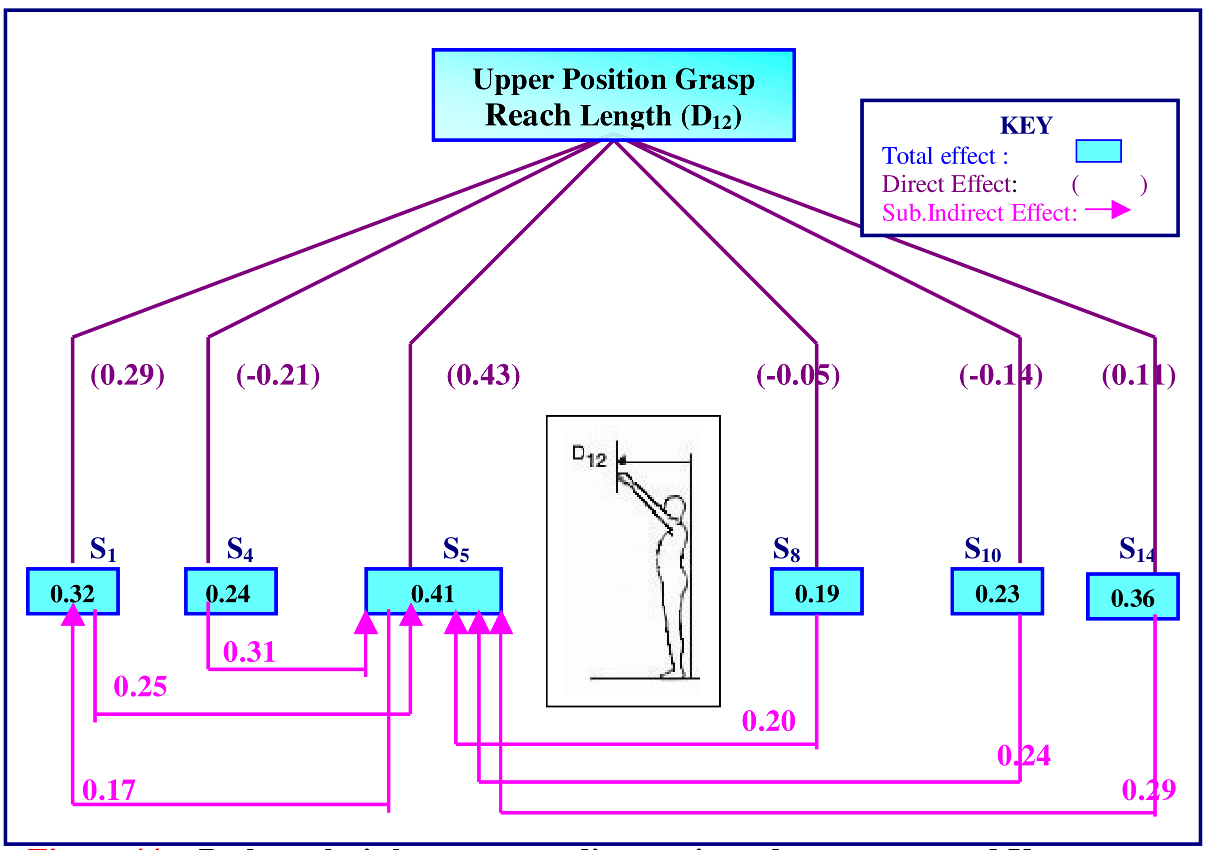


Figure 44: **Path analysis between standing static anthropometry and Upper Position Grasp Reach Length (D_{12}) of women**

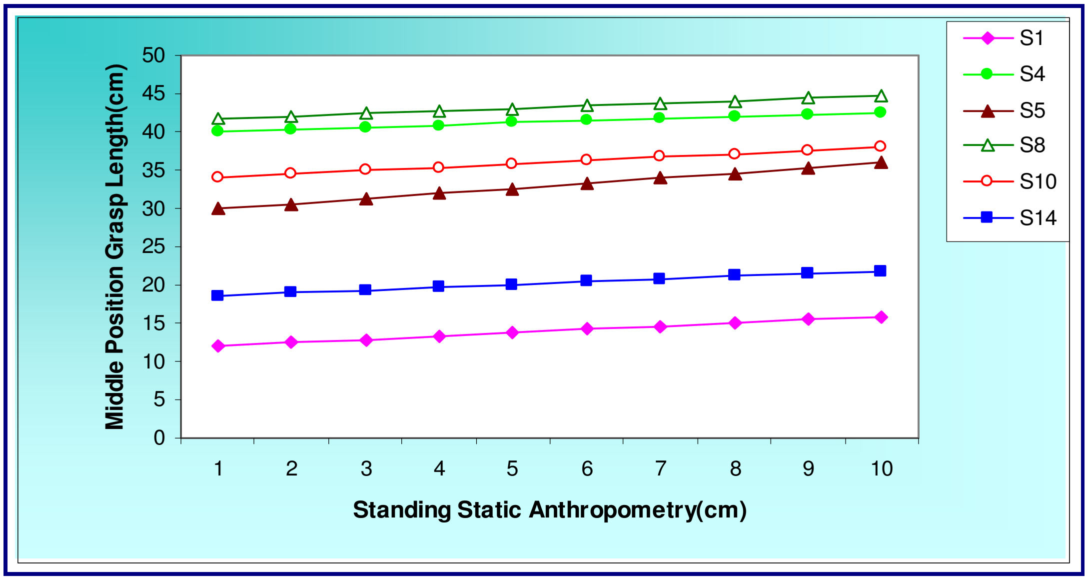


Figure 45: Regression analysis between standing static anthropometry and Mid Position Grasp Reach Length (D_{13}) of women

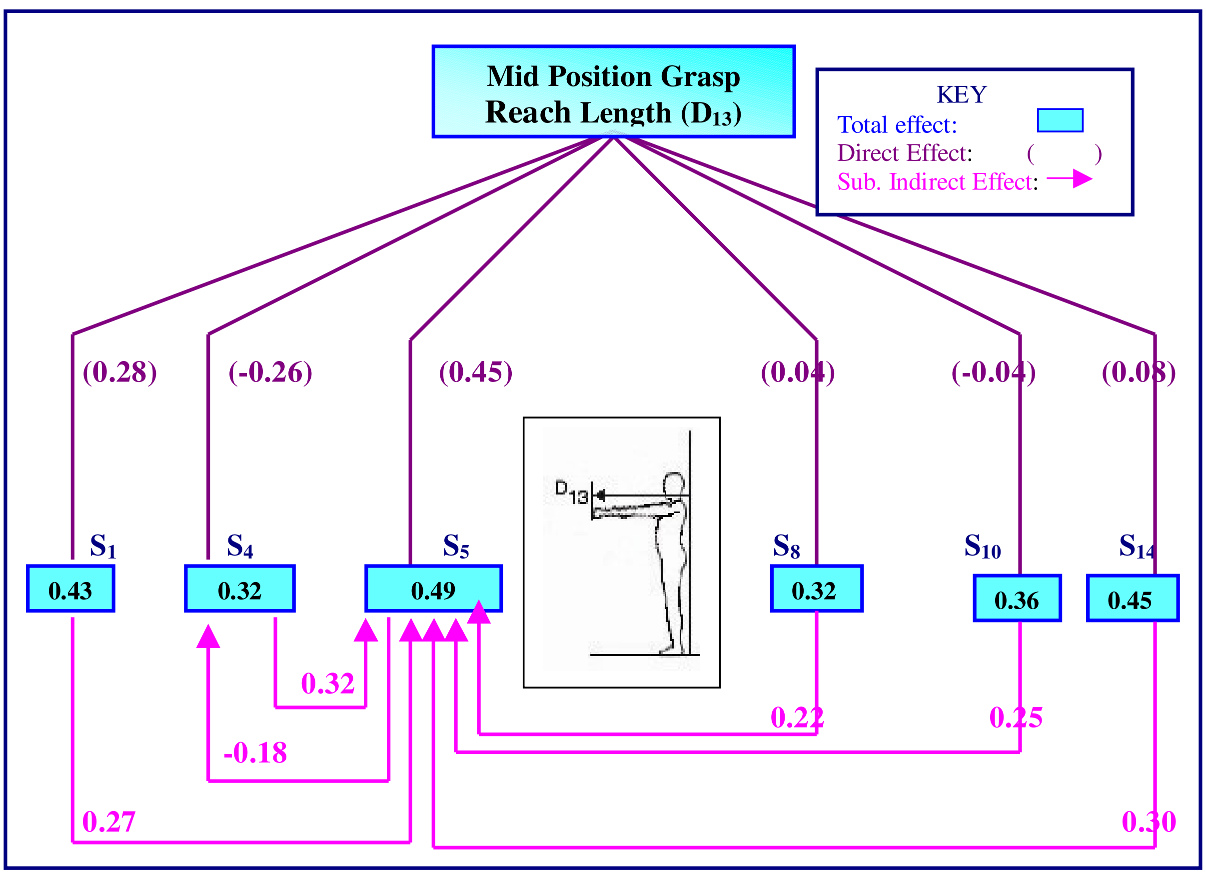


Figure 46: Path analysis between standing static anthropometry and Mid position Grasp Reach Length (D_{13}) of women

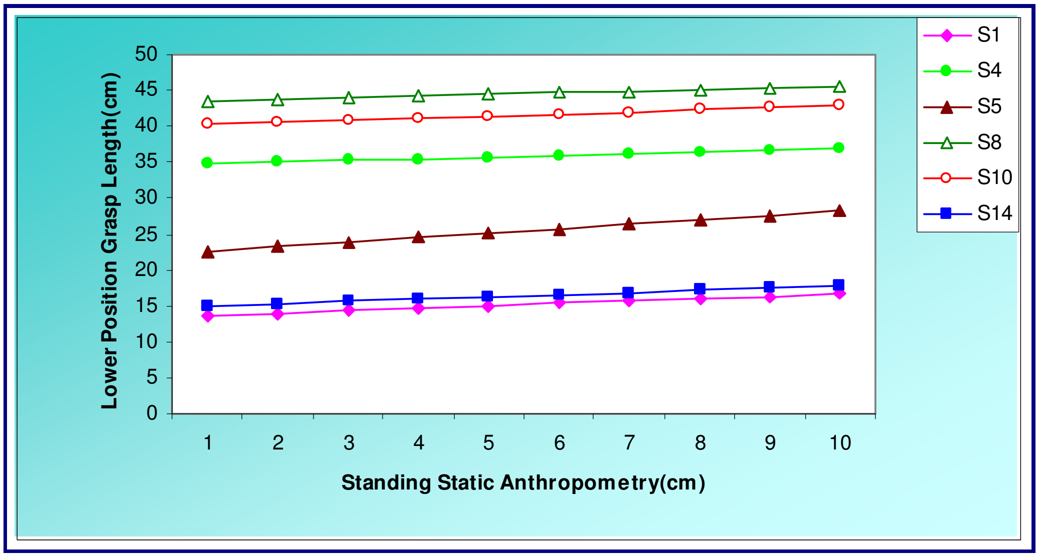


Figure 47: **Regression analysis between standing static anthropometry and Lower Position Grasp Reach Length (D_{14}) of women**

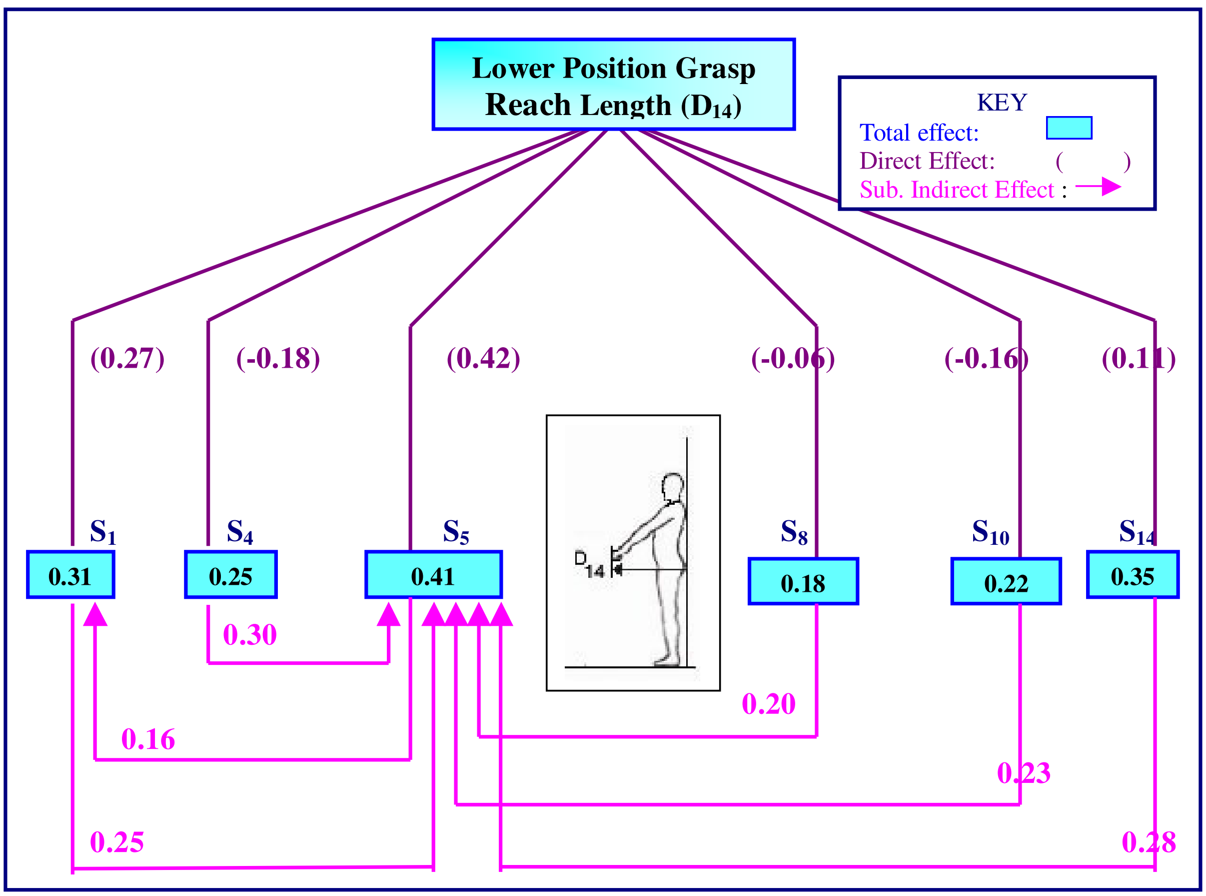


Figure 48 : **Path analysis between standing static anthropometry and Lower Position Grasp Reach Length (D_{14}) of women**

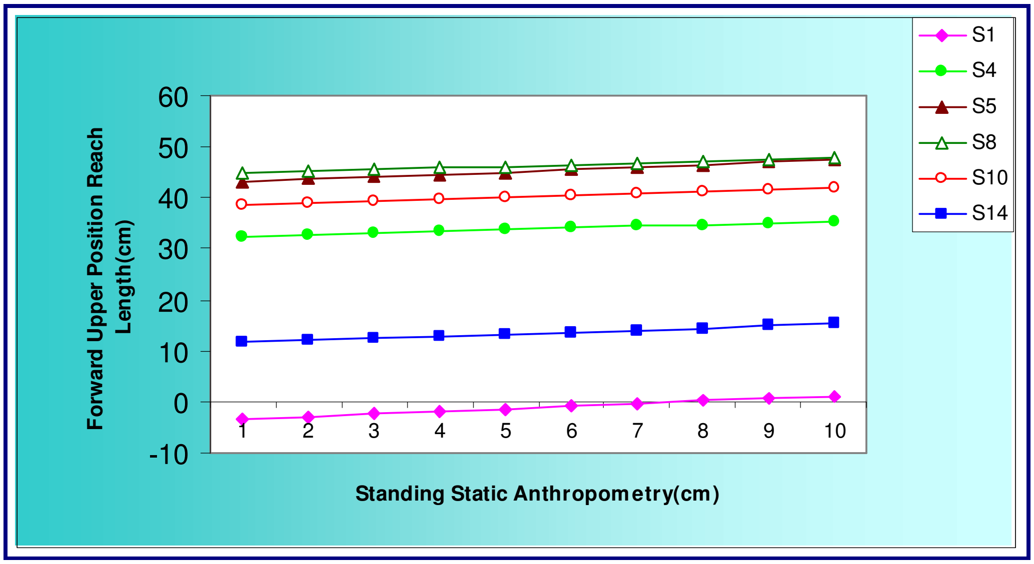


Figure 49: **Regression analysis between standing static anthropometry and Forward Upper Position Arm Reach Length (D_{15}) of women**

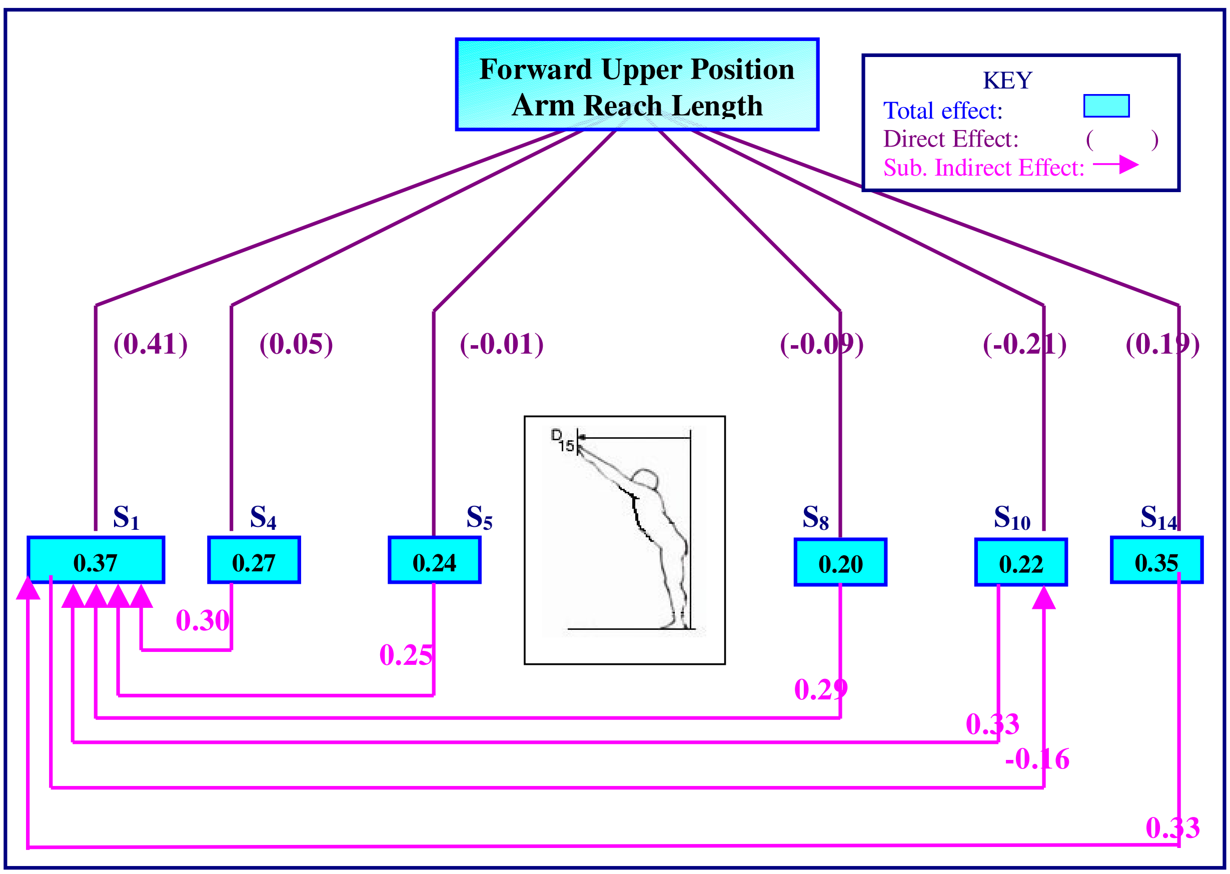


Figure 50: **Path analysis between standing static anthropometry and Forward Upper Position Arm Reach Length (D_{15}) of women**

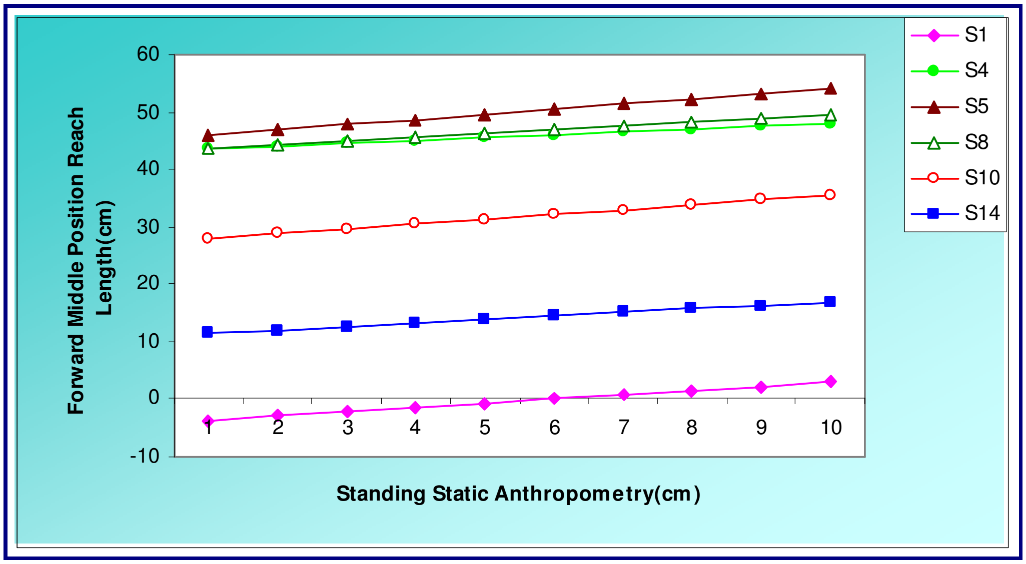


Figure 51: **Regression analysis between standing static anthropometry and Forward Mid Position Arm Reach Length (D_{16}) of women**

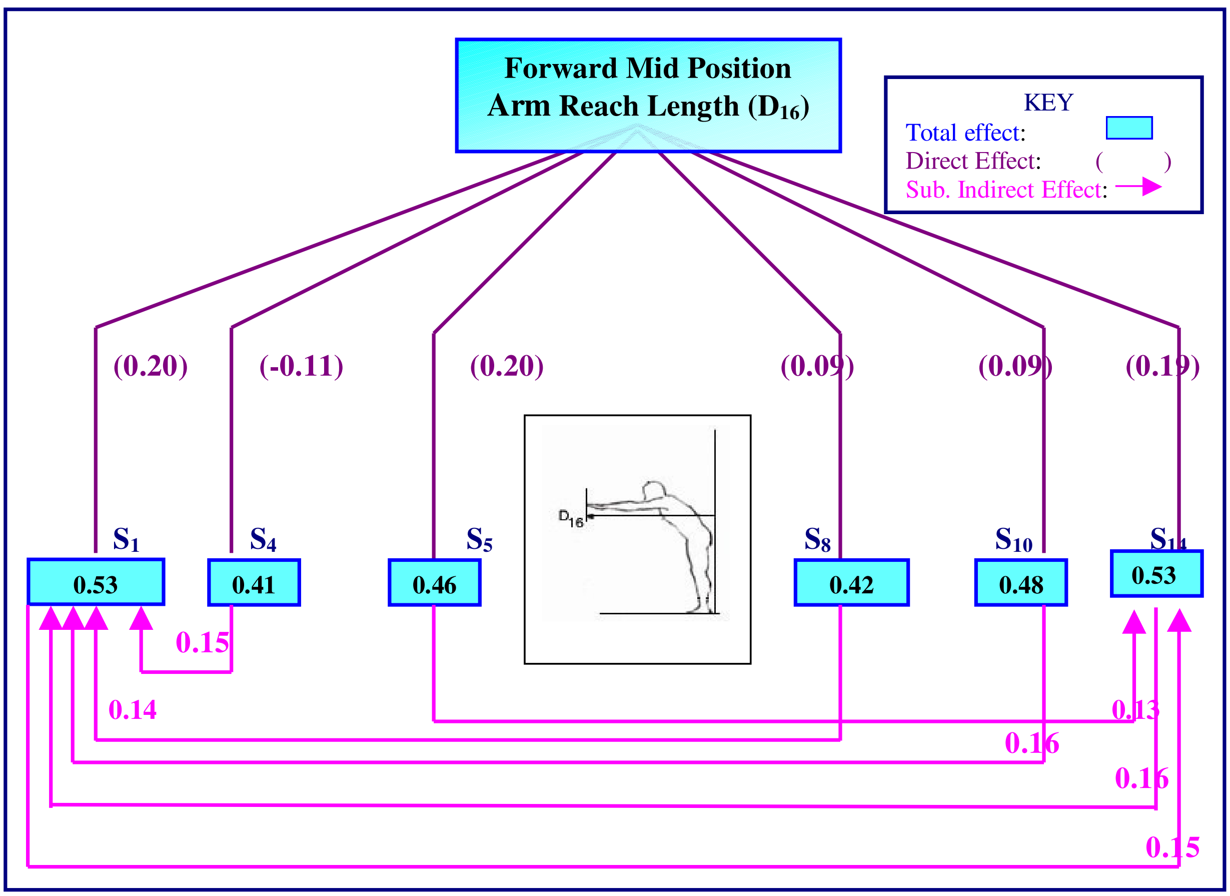


Figure 52: **Path analysis between standing static anthropometry and Forward Mid Position Arm Reach Length (D_{16}) of women**

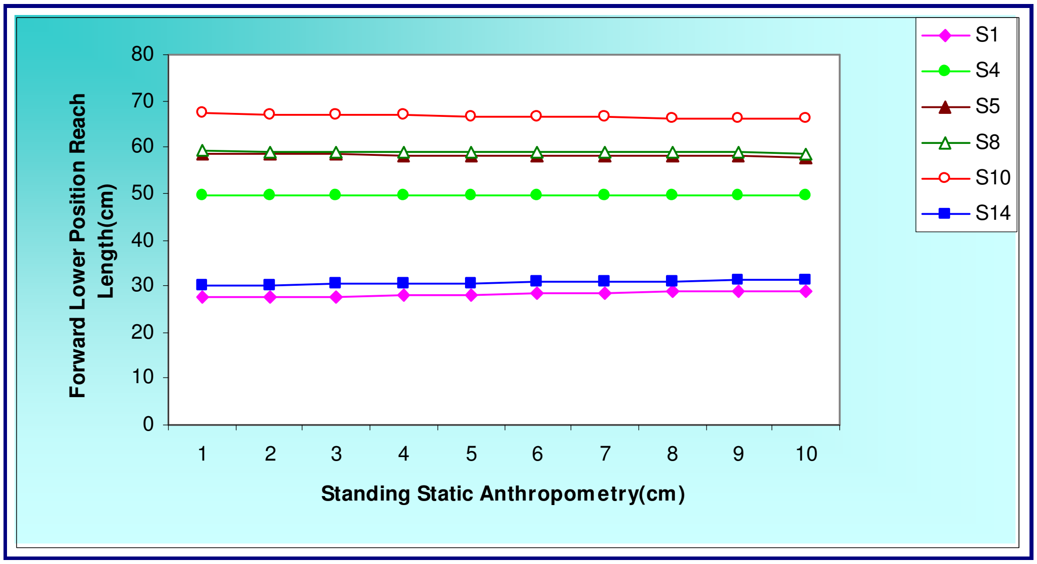


Figure 53: **Regression analysis between standing static anthropometry and Forward Lower Position Arm Reach Length (D_{17}) of women**

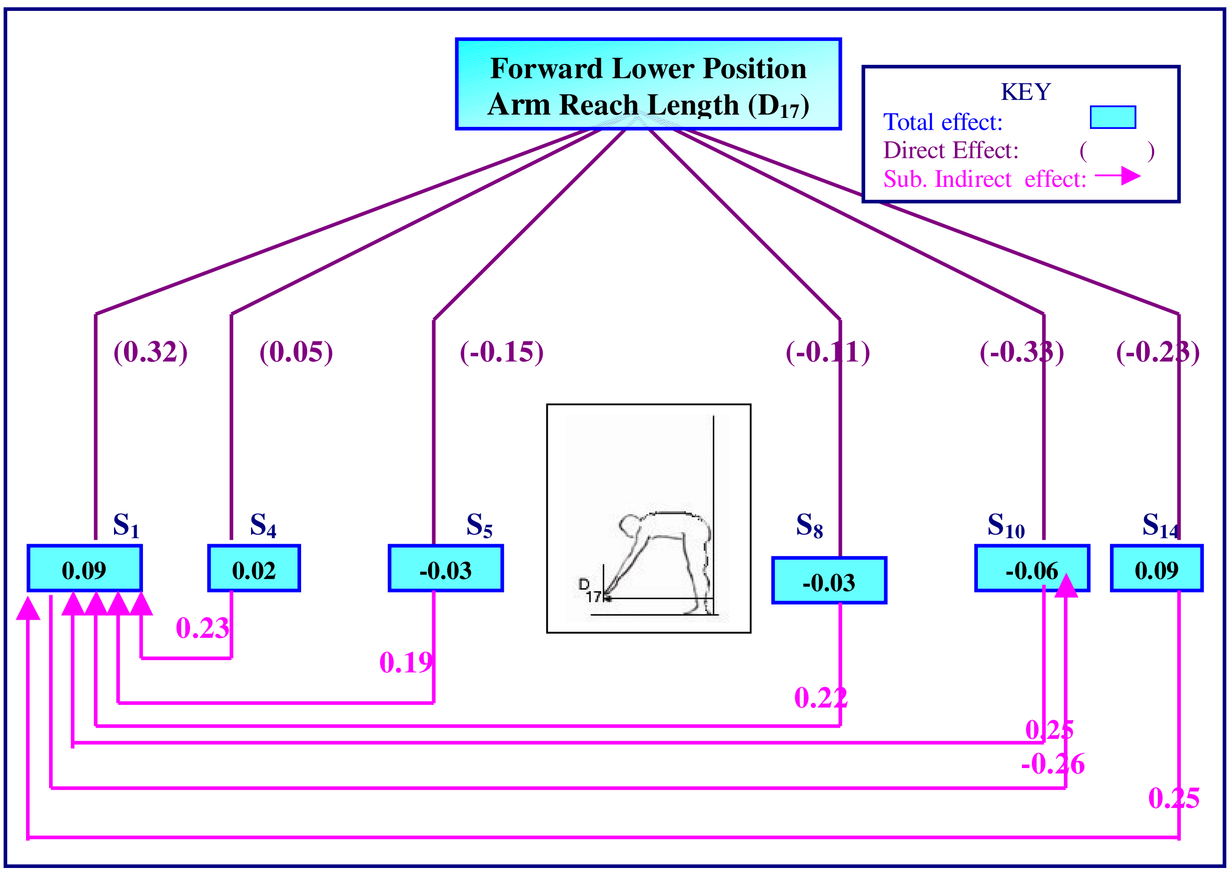


Figure 54: **Path analysis between standing static anthropometry and Forward Lower Position Arm Reach Length (D_{17}) of women**

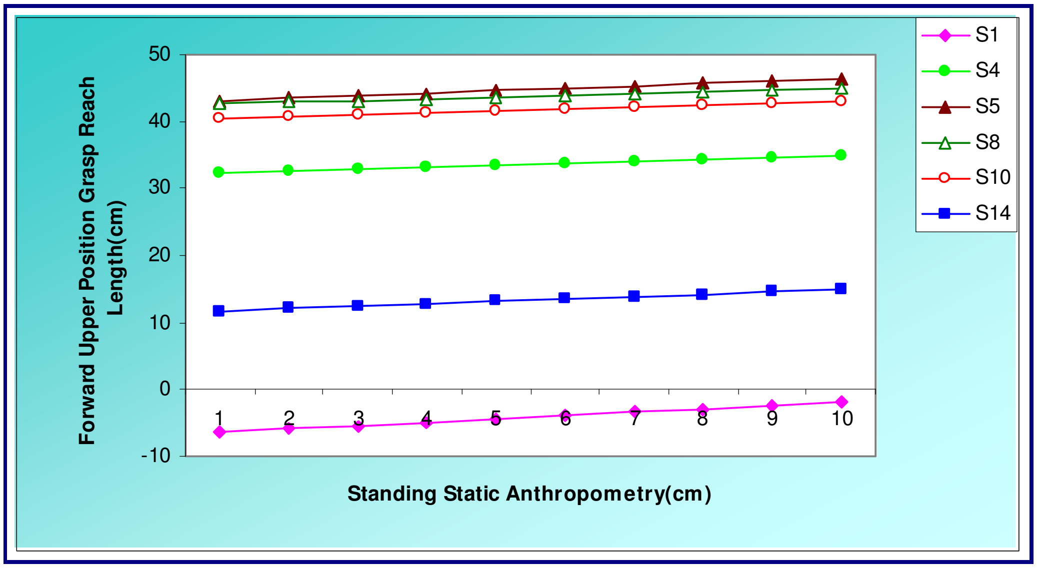


Figure 55: **Regression analysis between standing static anthropometry and Forward Upper Position Grasp Reach Length (D_{21}) of women**

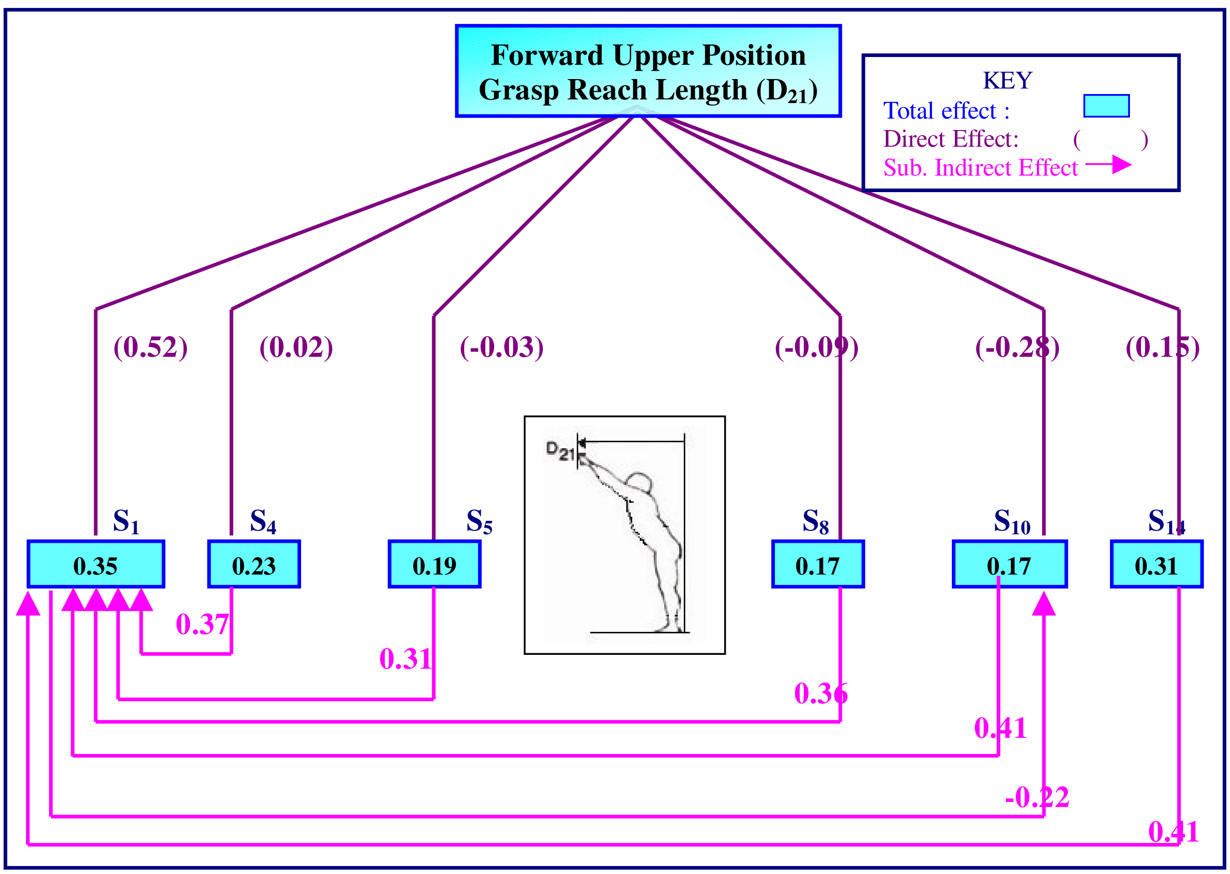


Figure 56: **Path analysis between standing static anthropometry and Forward Upper Position Grasp Reach Length (D_{21}) of women**

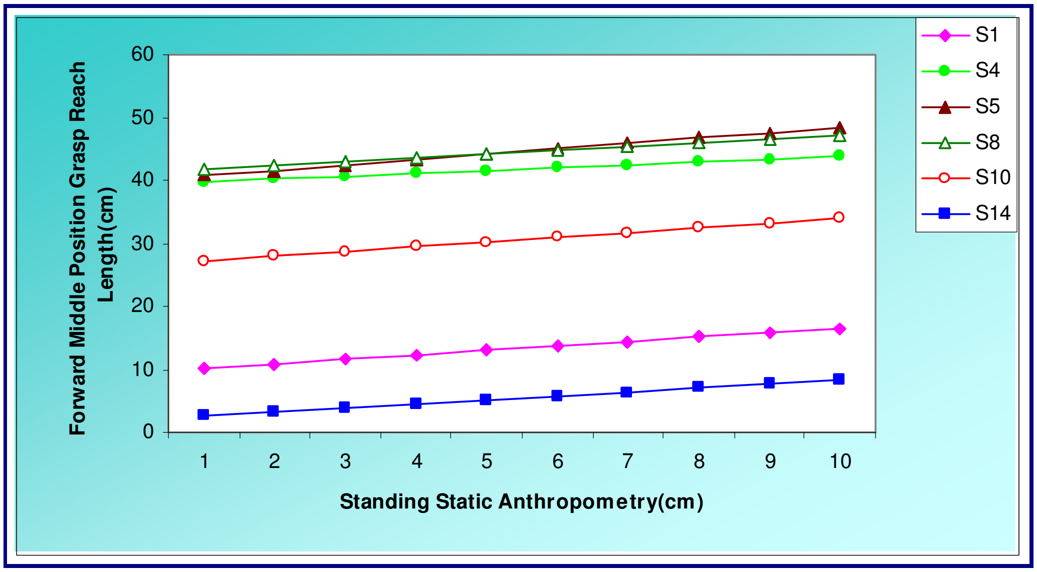


Figure 57: **Regression analysis between standing static anthropometry and Forward Mid Position Grasp Reach Length (D_{22}) of women**

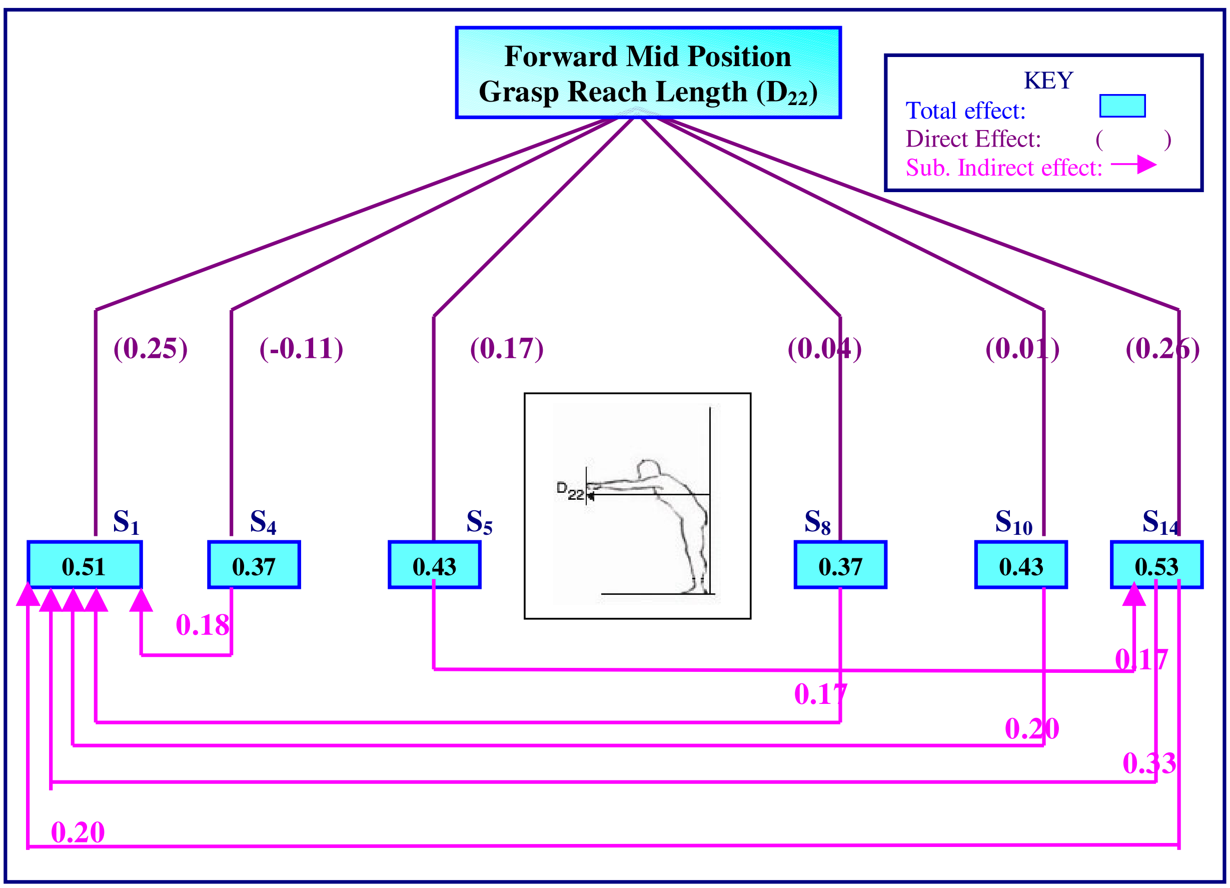


Figure 58: **Path analysis between standing static anthropometry and Forward Mid Position Grasp Reach Length (D_{22}) of women**

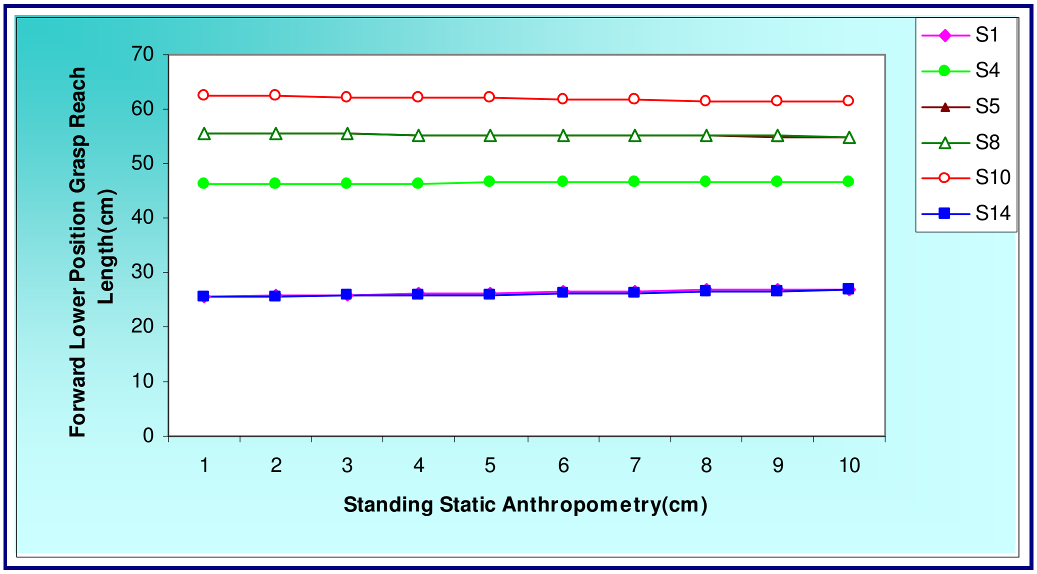


Figure 59: **Regression analysis between standing static anthropometry and Forward Lower Position Grasp Reach Length (D_{23}) of women**

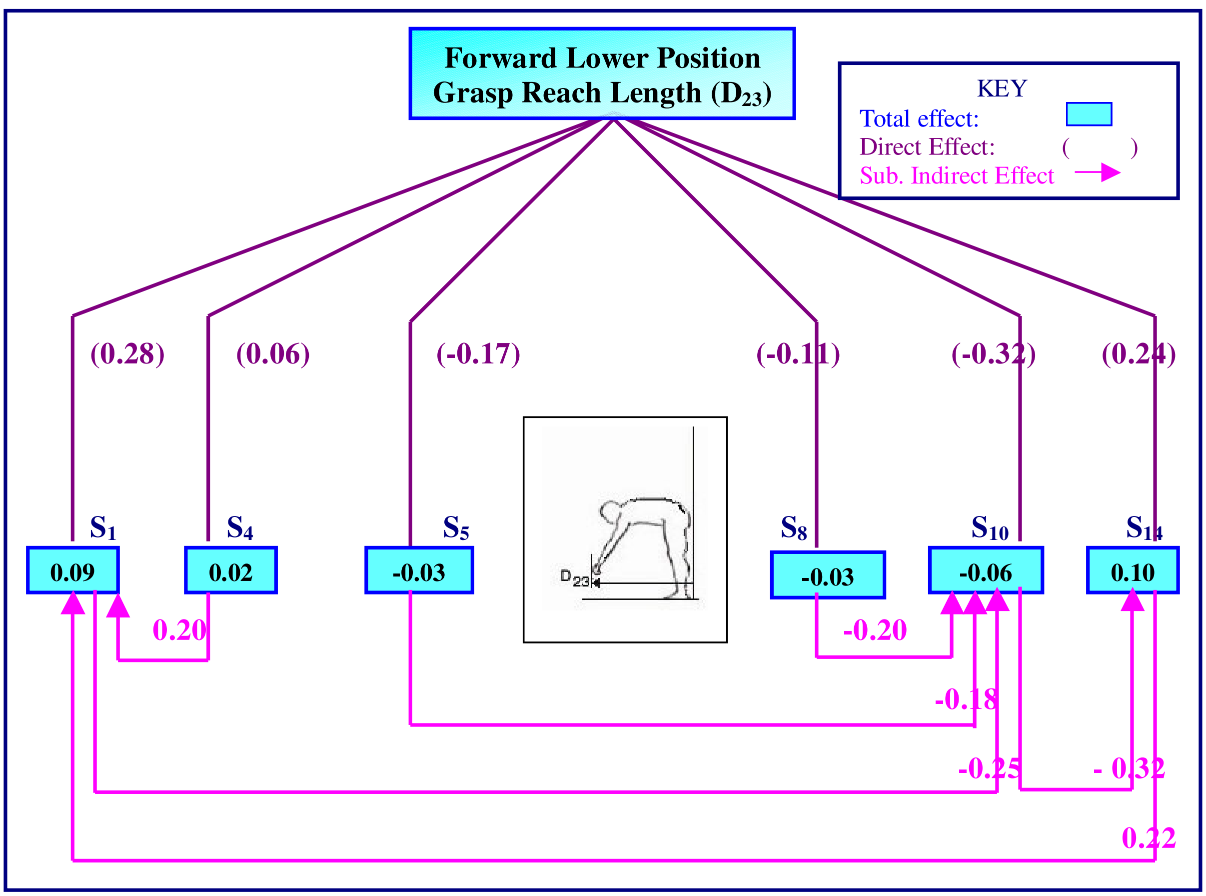


Figure 60: **Path analysis between standing static anthropometry and Forward Lower Position Grasp Reach Length (D_{23}) of women**

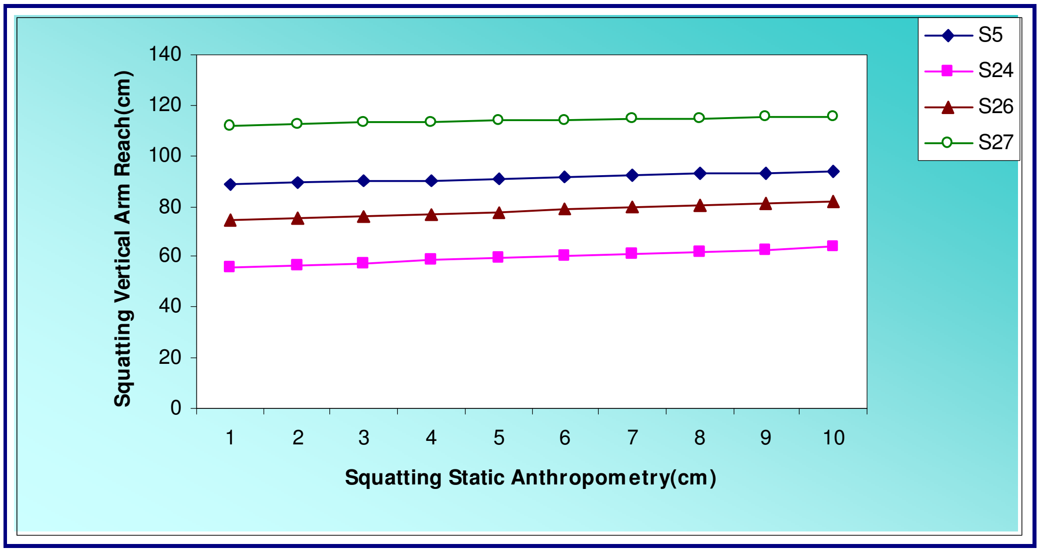


Figure 61: **Regression analysis between squatting static anthropometry and Vertical Arm Reach (D_{27}) of women**

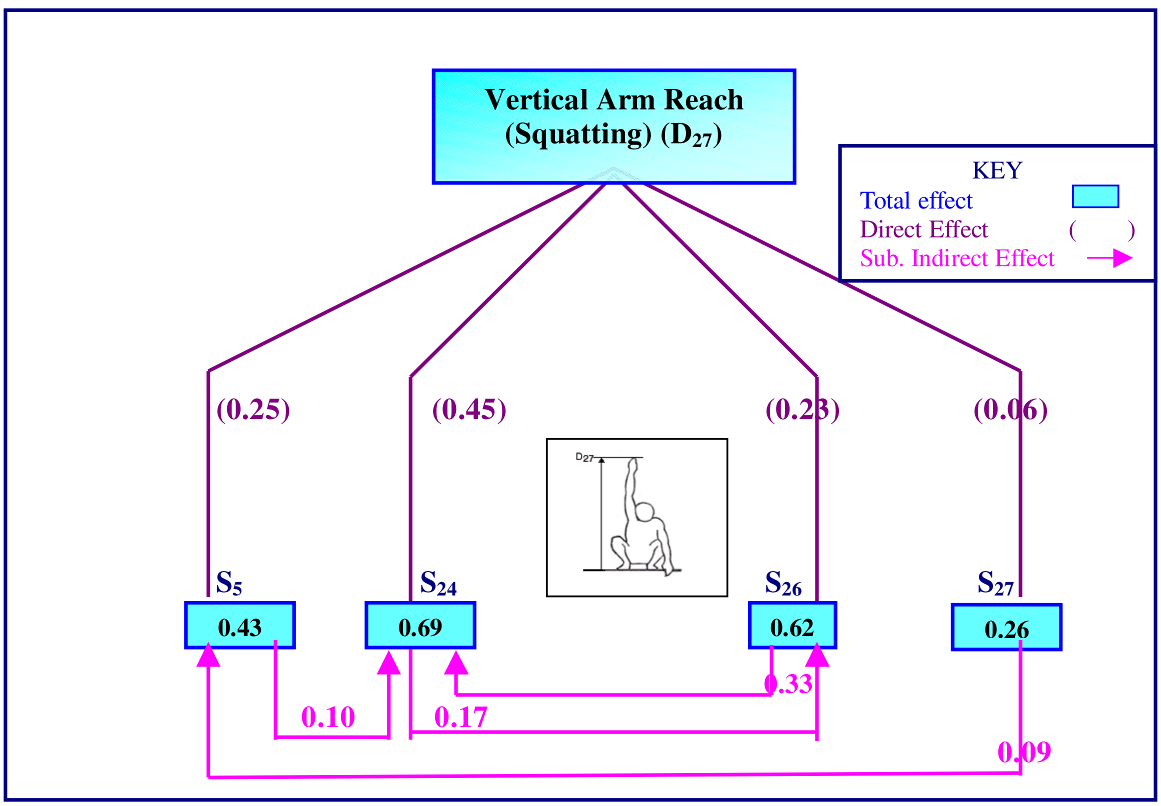


Figure 62: **Path analysis between squatting static anthropometry and Vertical Arm Reach (D_{27}) of women**

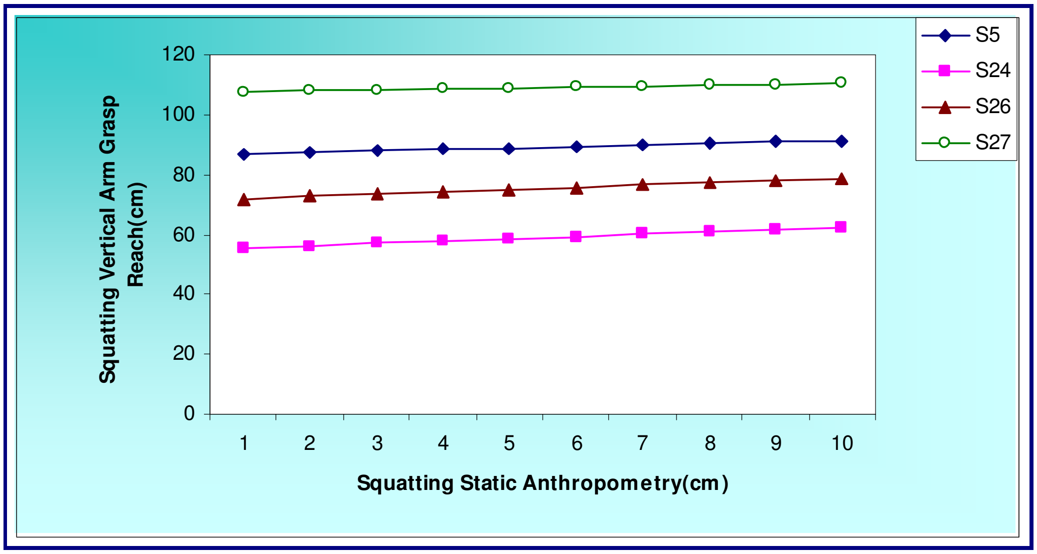


Figure 63: **Regression analysis between squatting static anthropometry and Vertical Grasp Reach (D_{28}) of women**

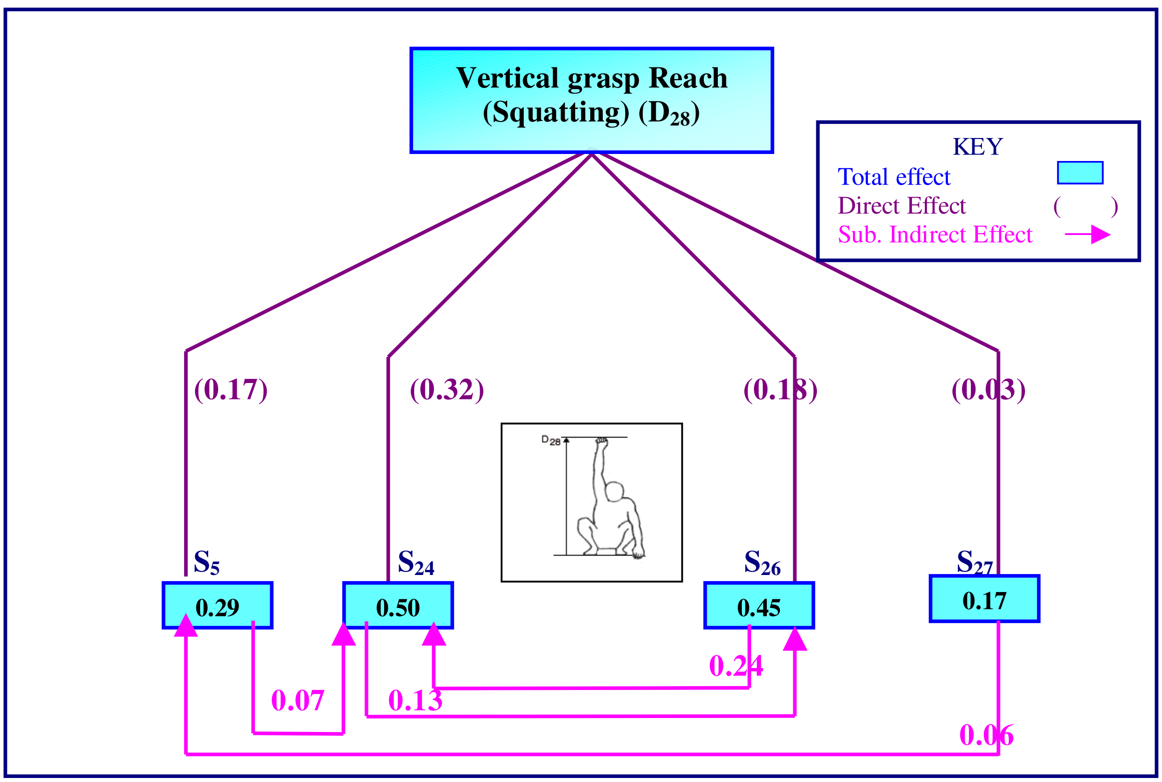


Figure 64: **Path analysis between squatting static anthropometry and Vertical Grasp Reach (D_{28}) of women**

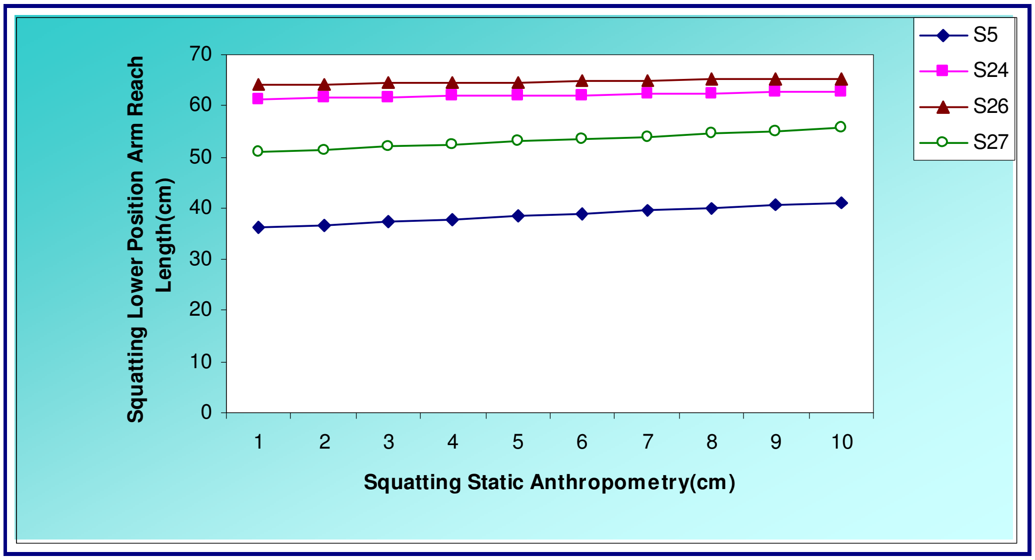


Figure 65: **Regression analysis between squatting static anthropometry and Upper Position Arm Reach Length (D_{29}) of women**

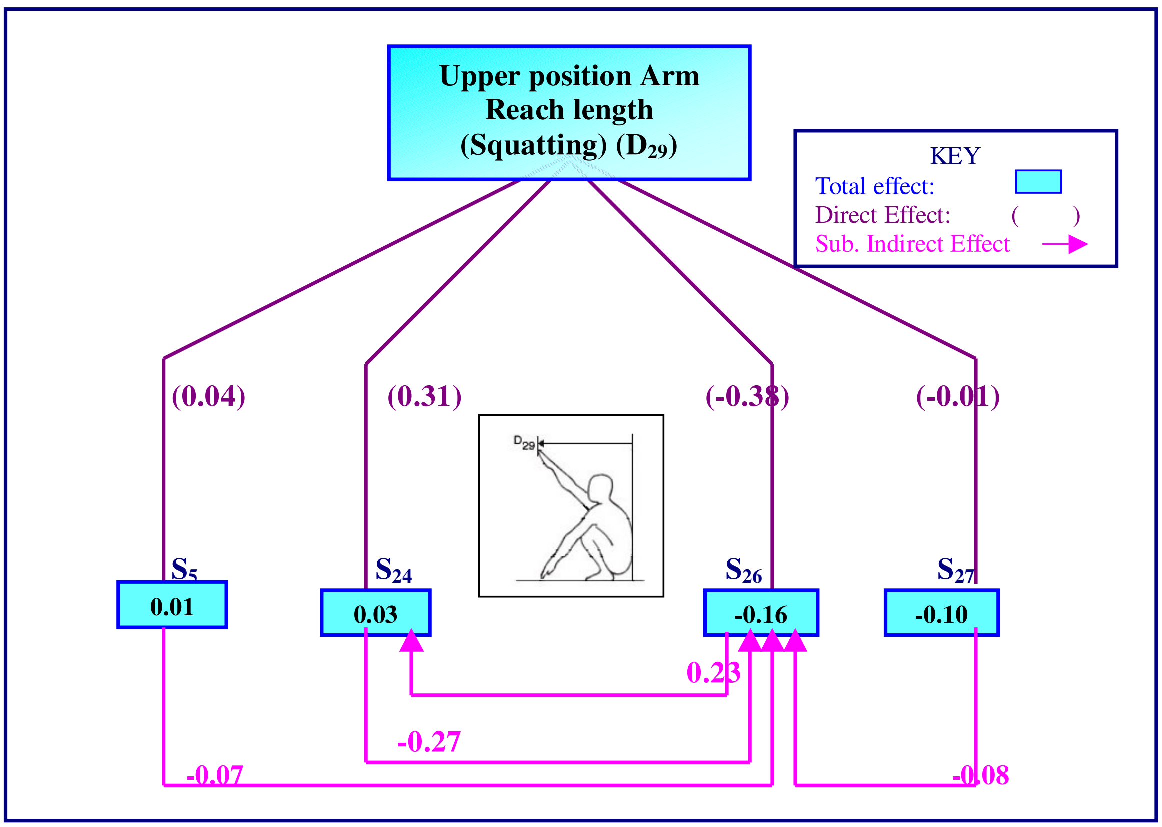


Figure 66: **Path analysis between squatting static anthropometry and Upper Position Arm Reach Length (D_{29}) of women**

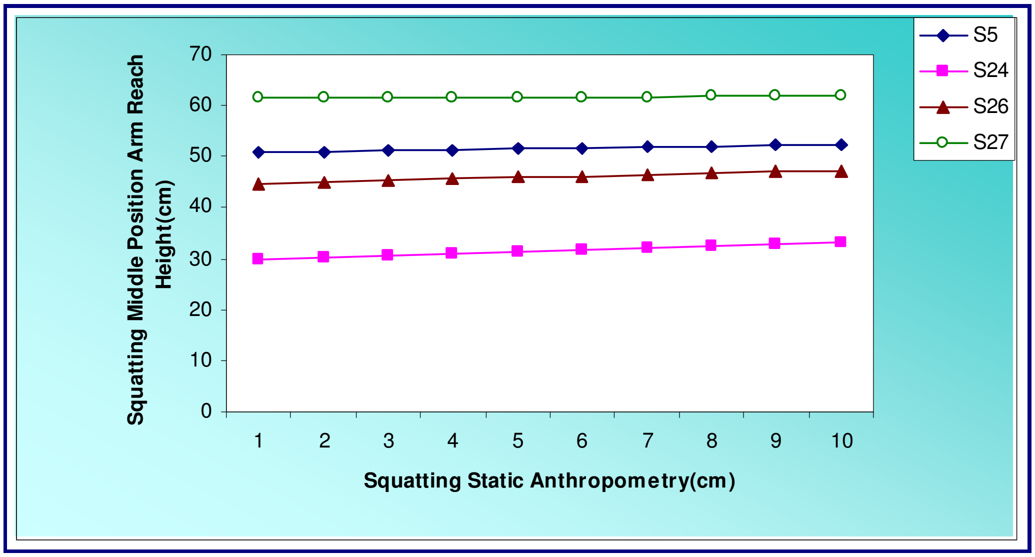


Figure 67: **Regression analysis between squatting static anthropometry and Mid Position Arm Reach Length (D_{30}) of women**

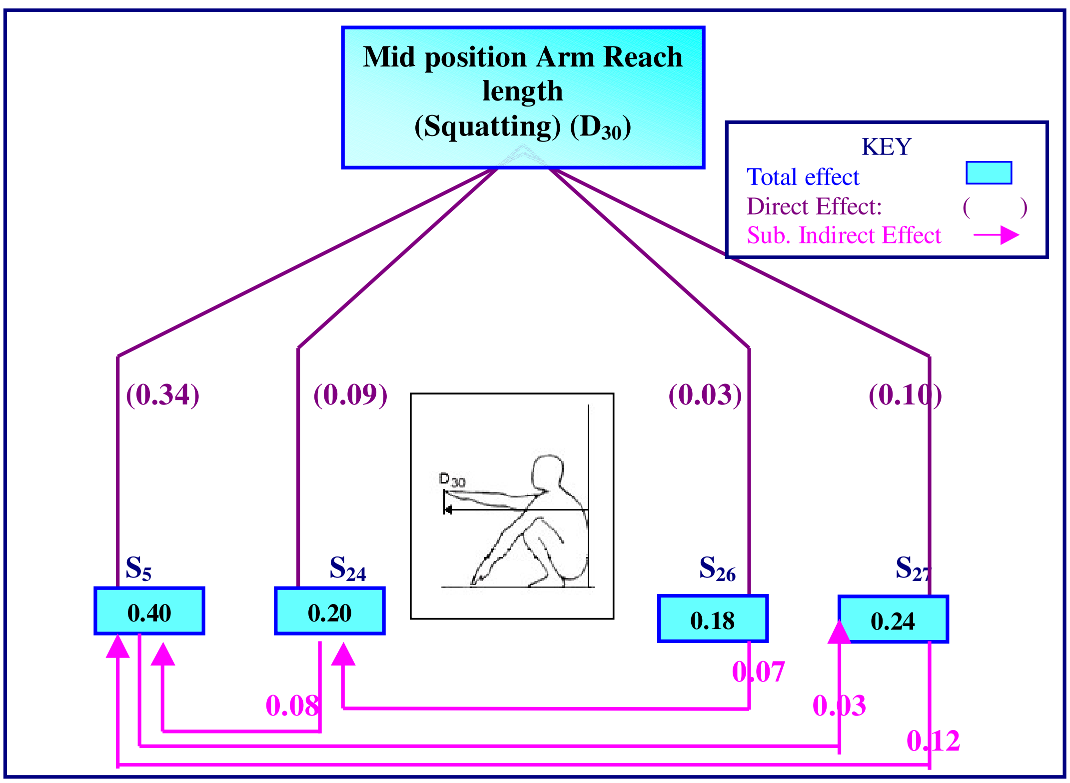


Figure 68: **Path analysis between squatting static anthropometry and Mid Position Arm Reach Length (D_{30}) of women**

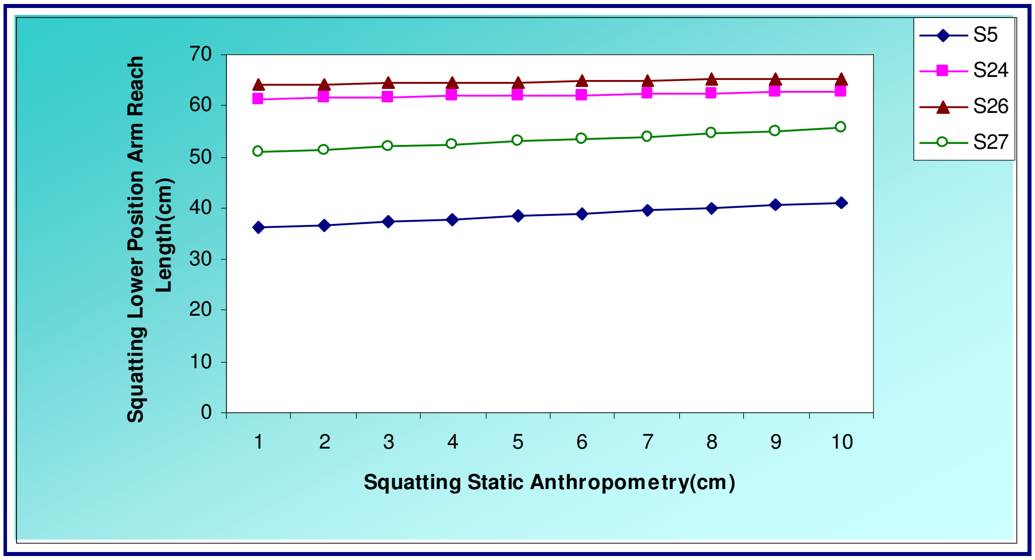


Figure 69: **Regression analysis between squatting static anthropometry and Lower Position Arm Reach Length (D_{31}) of women**

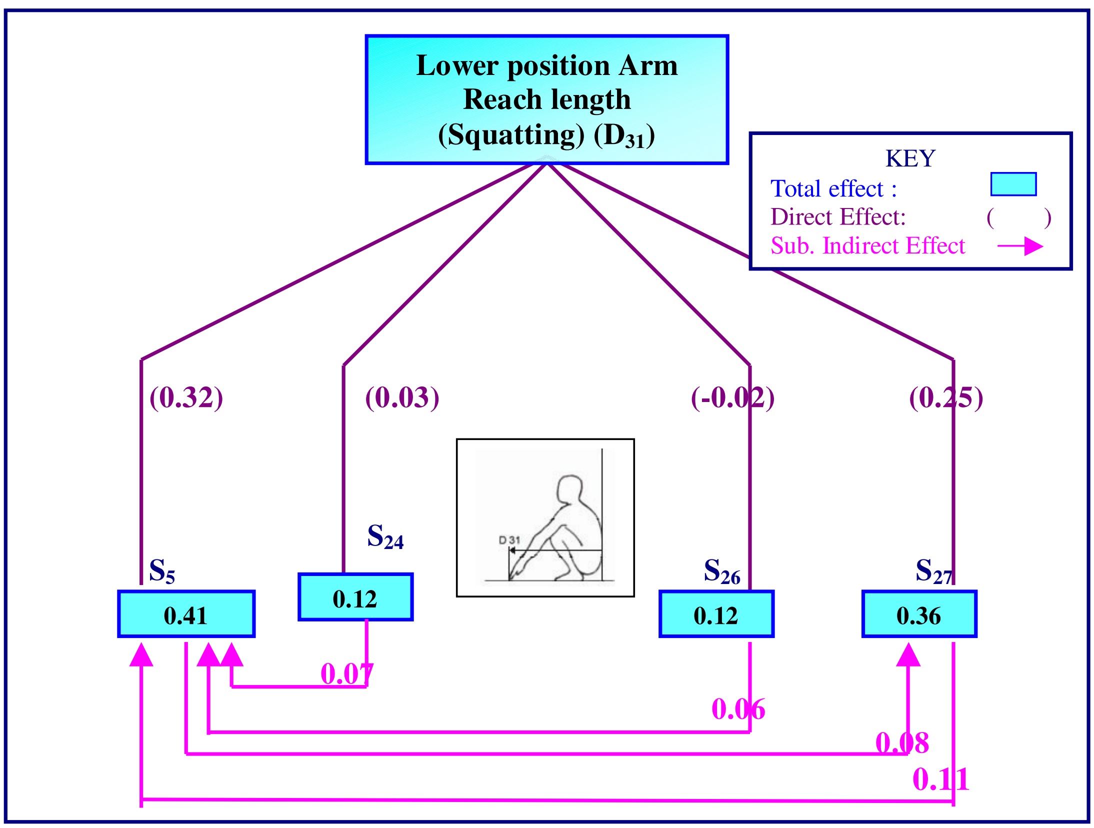


Figure 70: **Path analysis between squatting static anthropometry and Squatting Lower Position Arm Reach Length (D_{31}) of women**

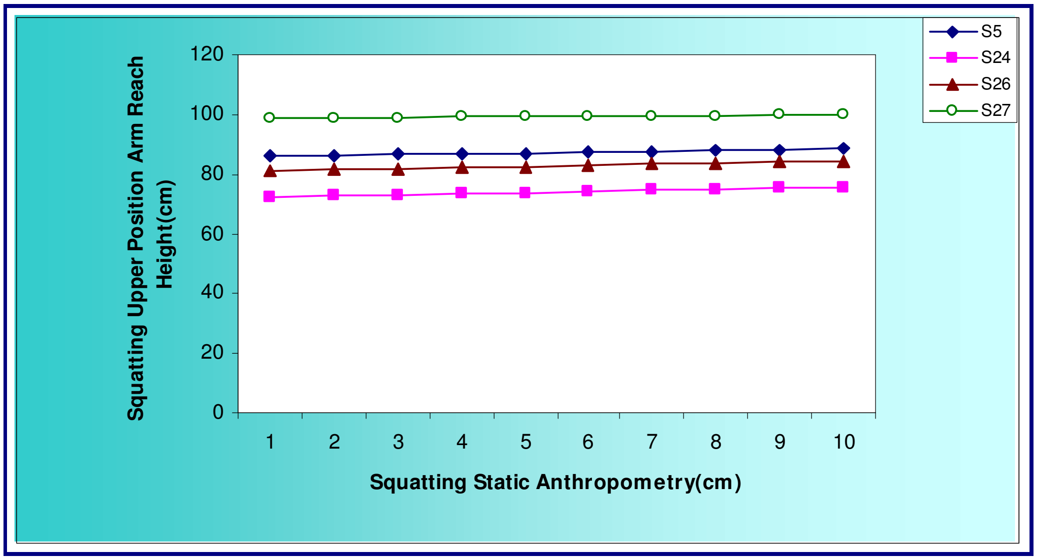


Figure 71: **Regression analysis between squatting static anthropometry and Upper Position Arm Reach Height (D_{32}) of women**

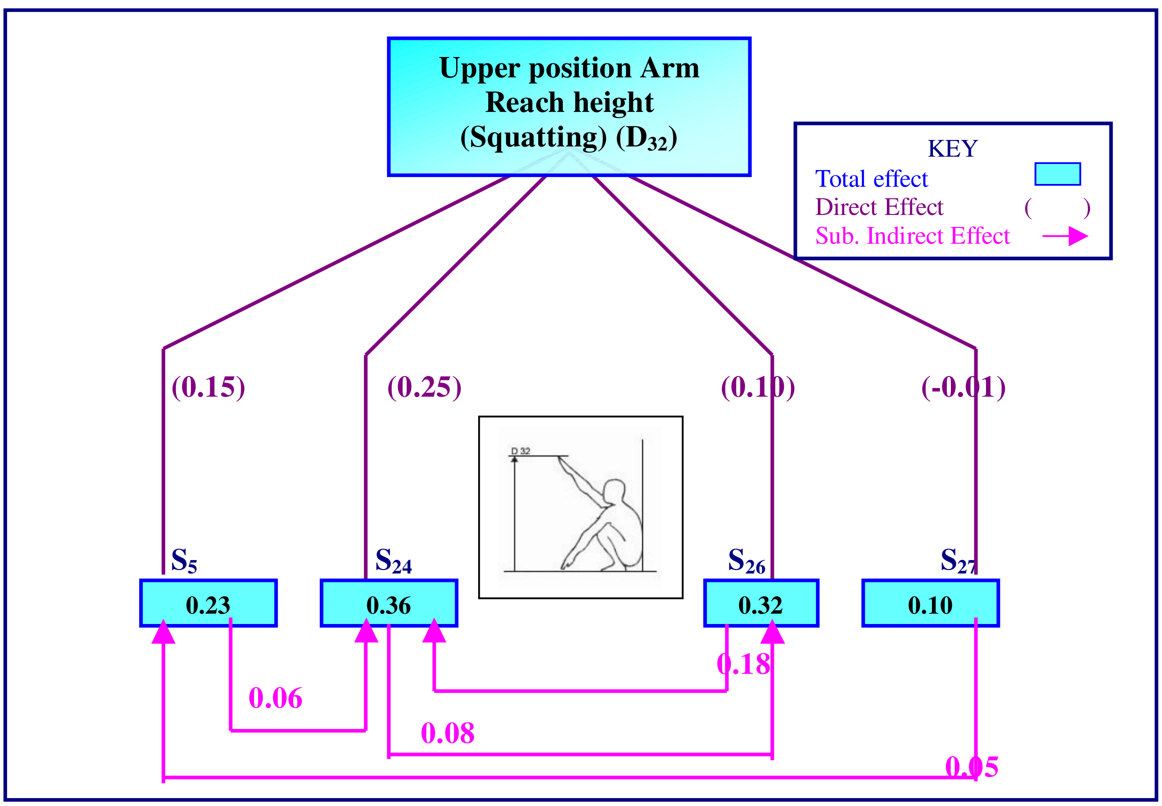


Figure 72: **Path analysis between squatting static anthropometry and Upper Position Arm Reach Height (D_{32}) of women**

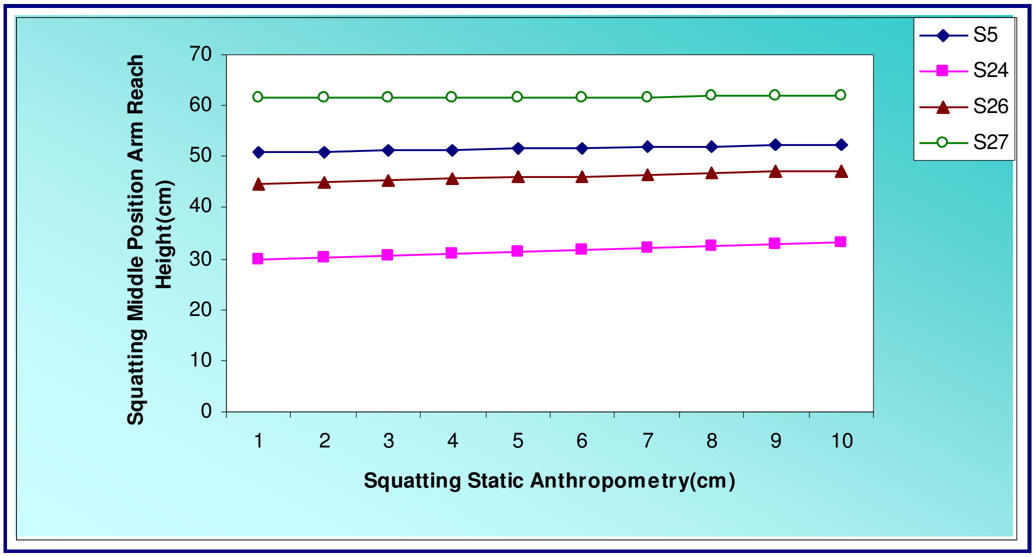


Figure 73: **Regression analysis between squatting static anthropometry and Mid Position Arm Reach Height (D_{33}) of women**

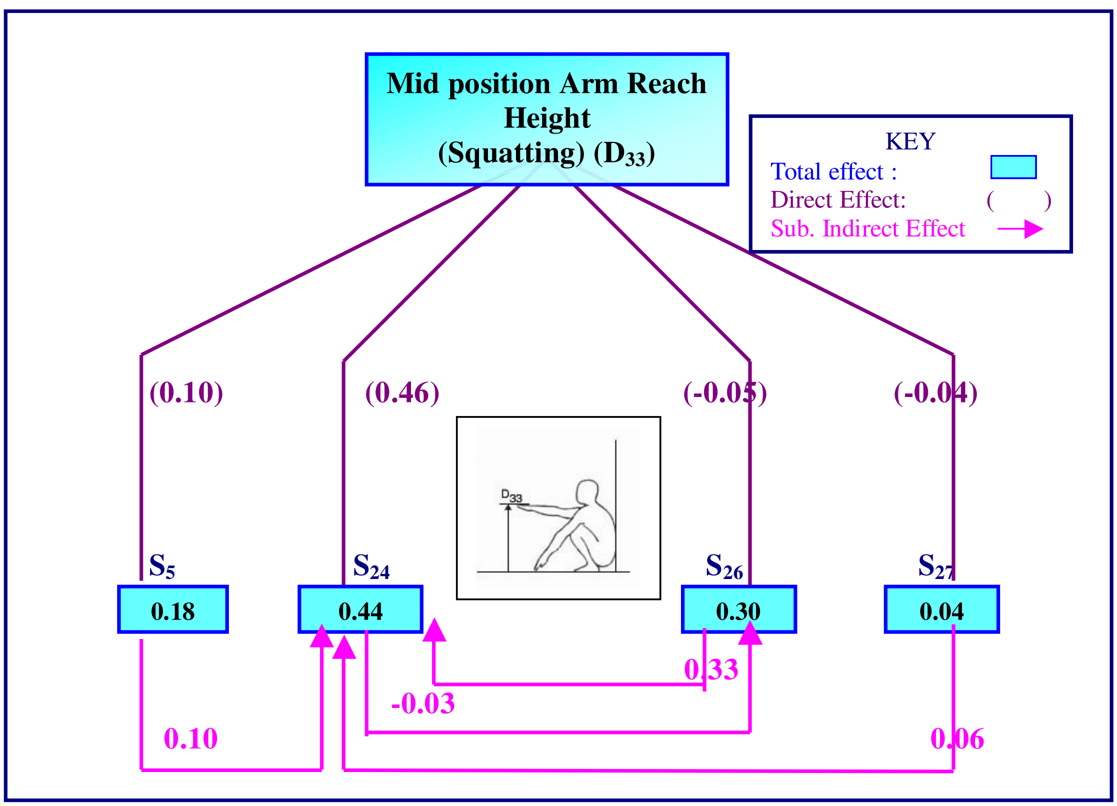


Figure 74: **Path analysis between squatting static anthropometry and Mid Position Arm Reach Height (D_{33}) of women**

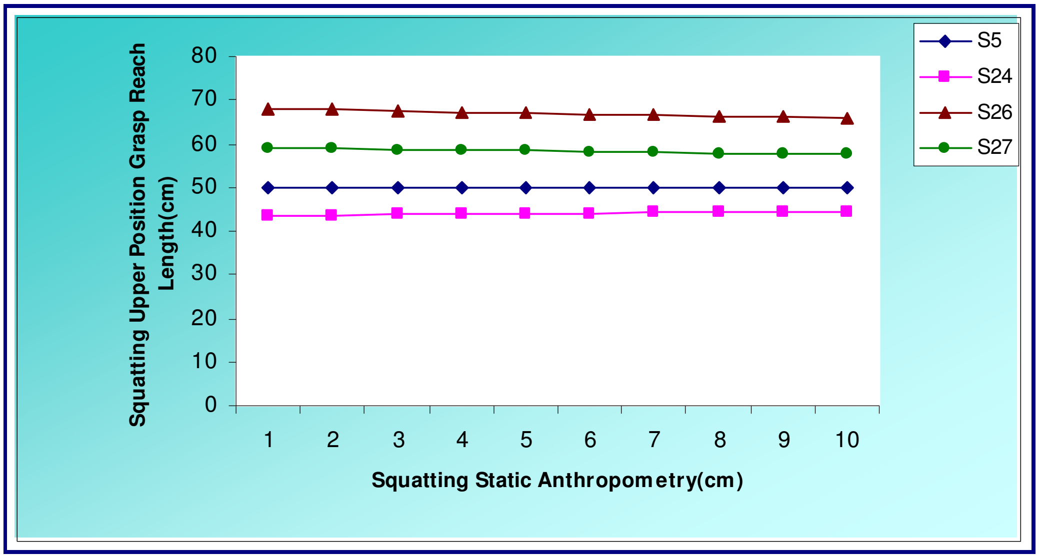


Figure 75: **Regression analysis between squatting static anthropometry and Upper Position Grasp Reach Length (D_{34}) of women**

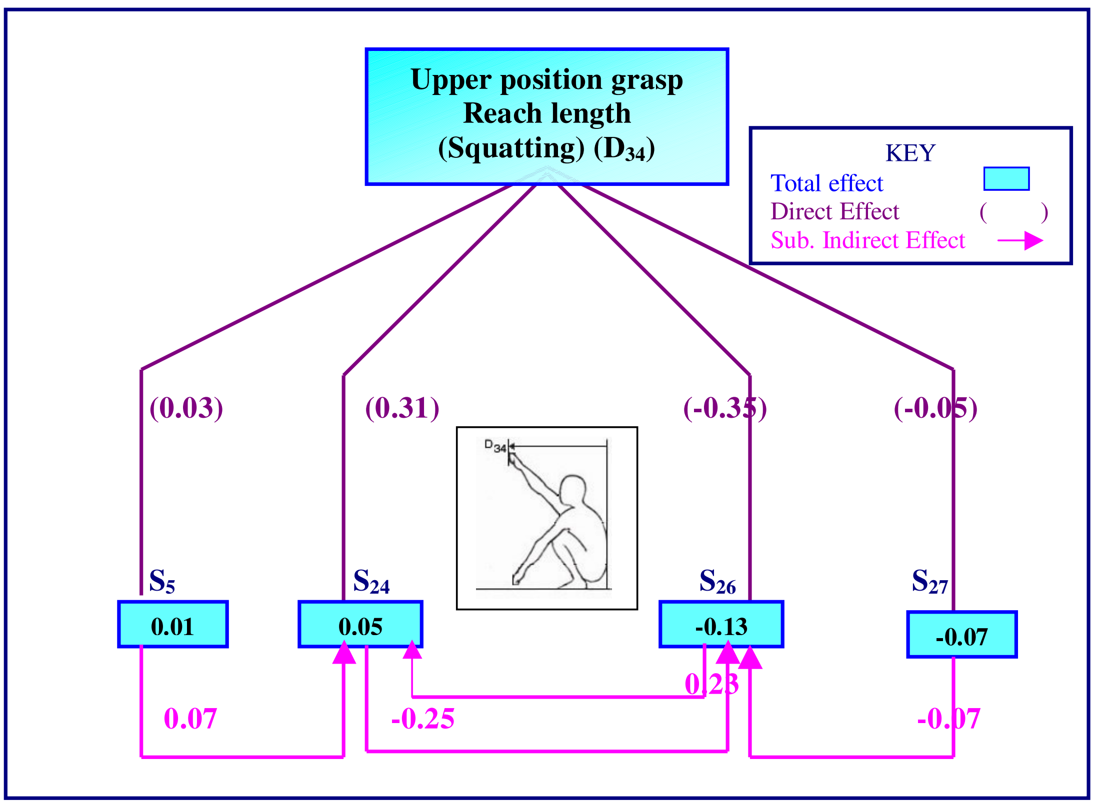


Figure 76: **Path analysis between squatting static anthropometry and Upper Position Grasp Reach Length (D_{34}) of women**

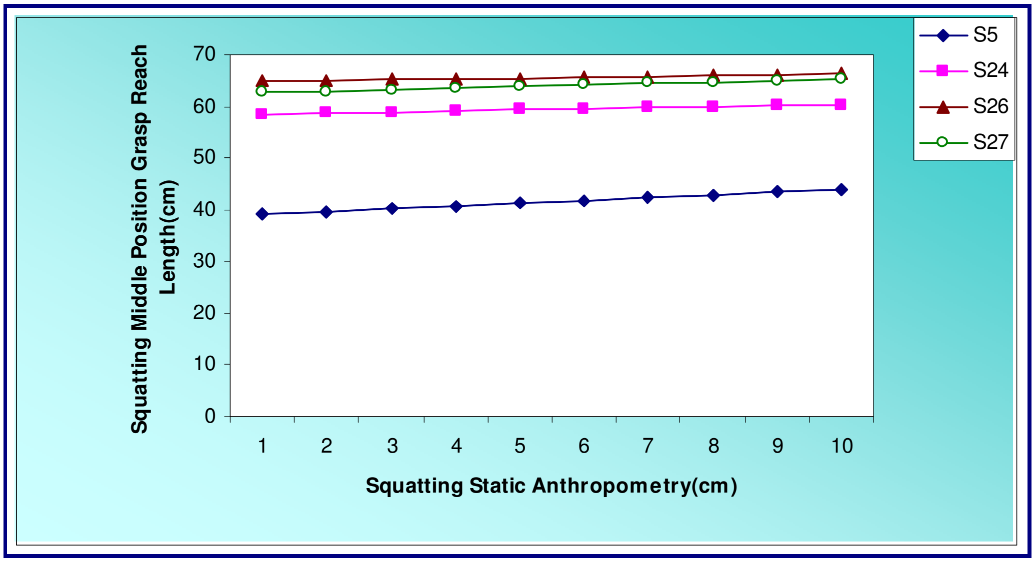


Figure 77: **Regression analysis between squatting static anthropometry and Mid Position Grasp Reach Length (D_{35}) of women**

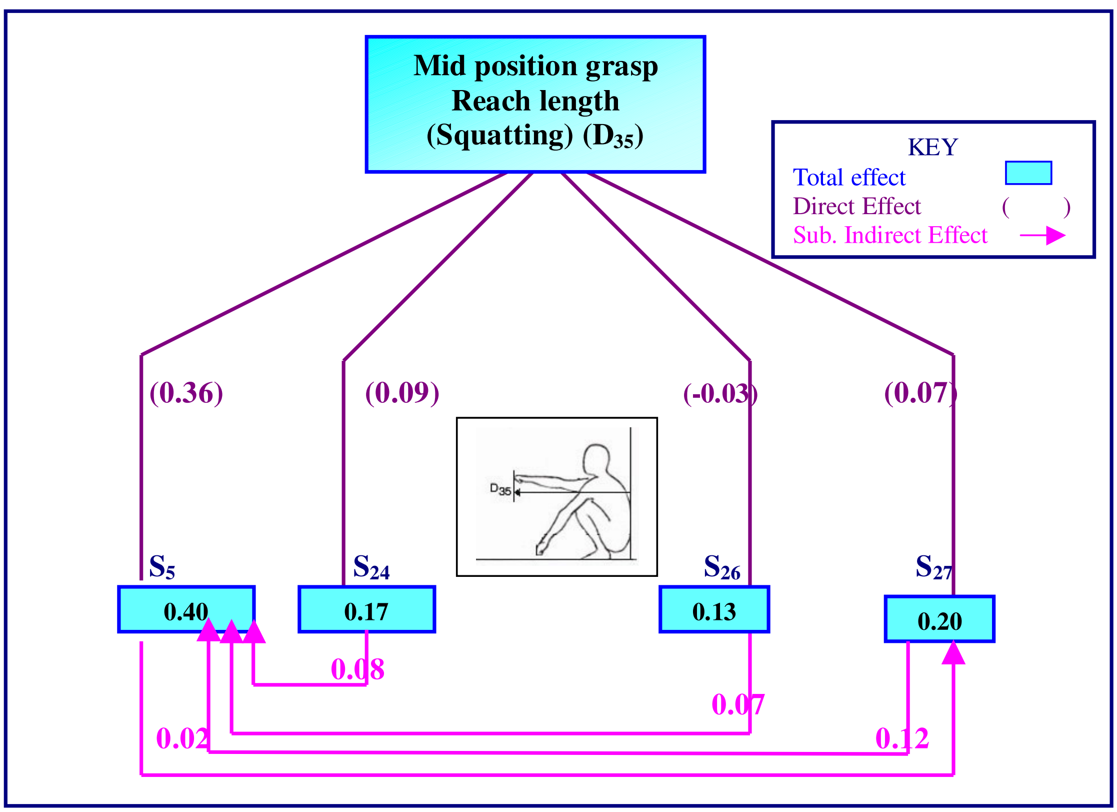


Figure 78: **Path analysis between squatting static anthropometry and Mid Position Grasp Reach Length (D_{35}) of women**

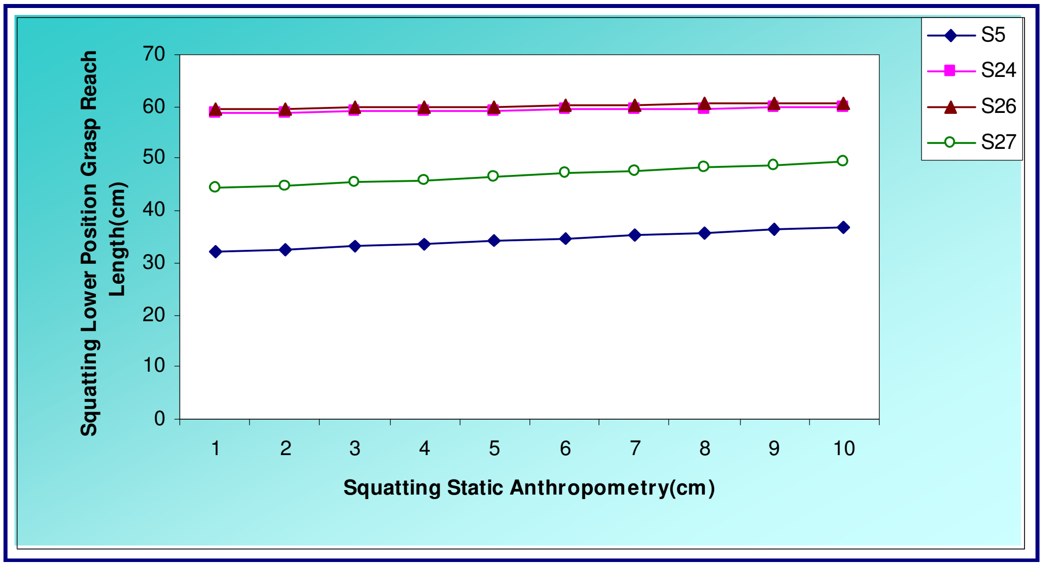


Figure 79: Regression analysis between squatting static anthropometry and Lower Position Grasp Reach Length (D_{36}) of women

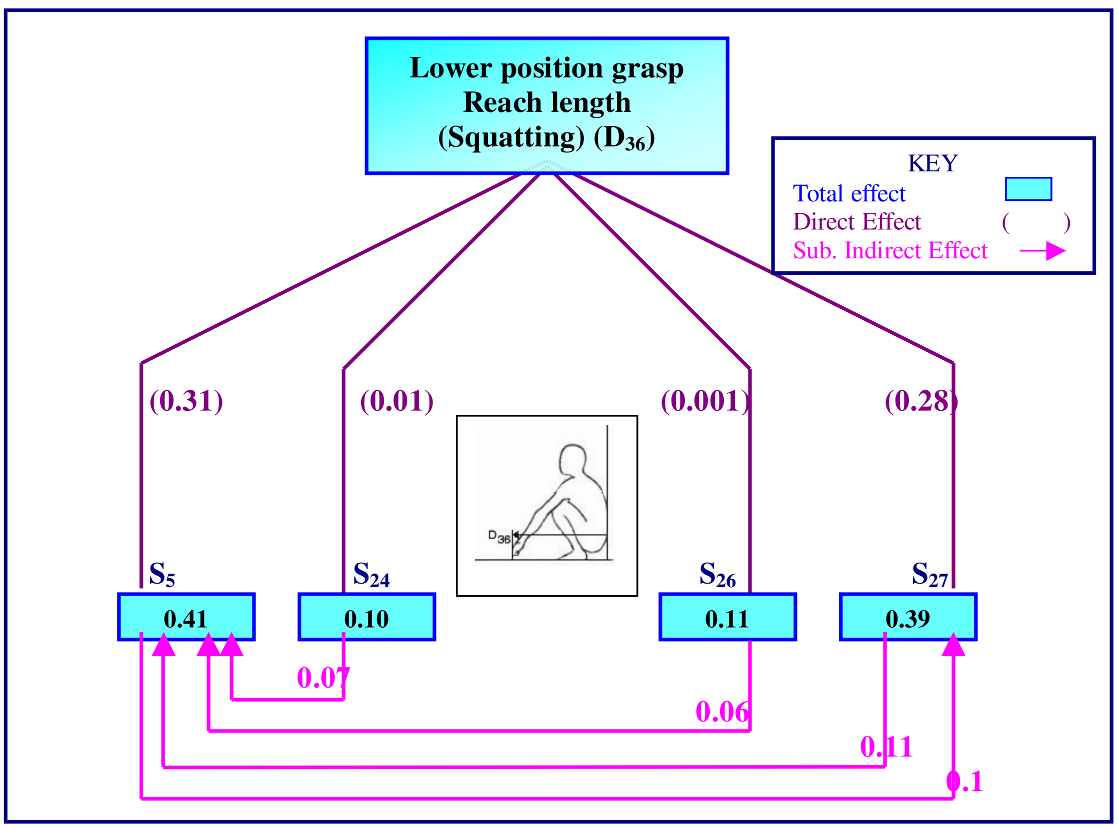


Figure 80: Path analysis between squatting static anthropometry and Lower Position Grasp Reach Length (D_{36}) of women

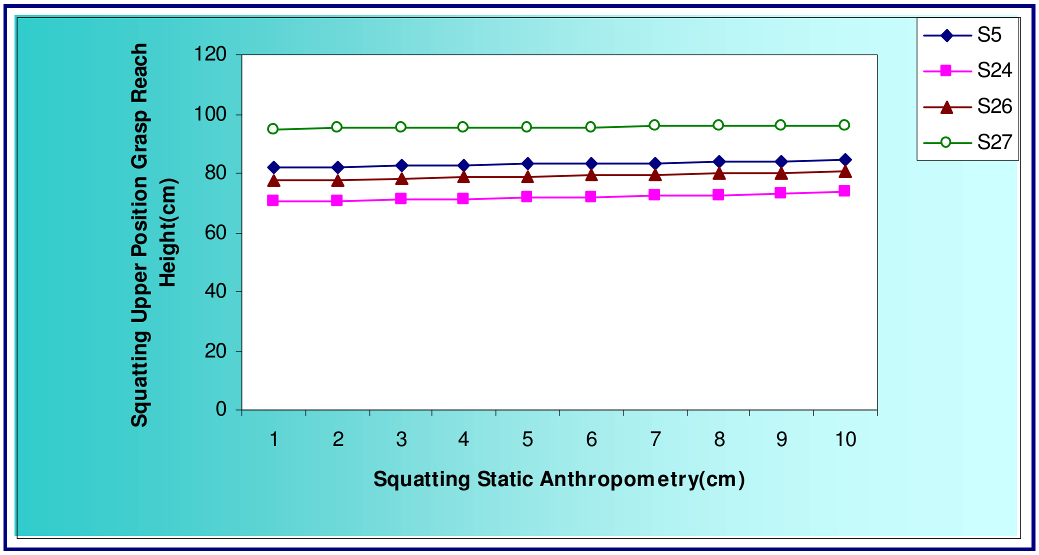


Figure 81: **Regression analysis between squatting static anthropometry and Upper Position Grasp Reach Height (D_{37}) of women**

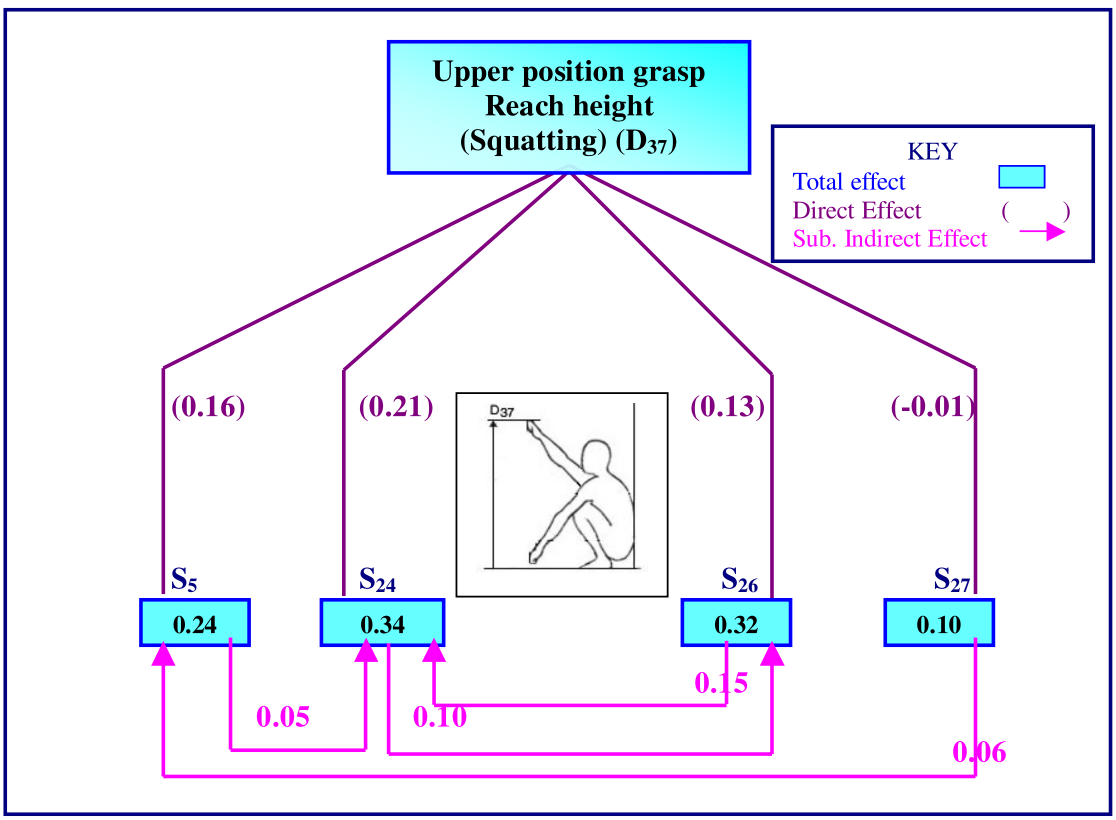


Figure 82: **Path analysis between squatting static anthropometry and Upper Position Grasp Reach Height (D_{37}) of women**

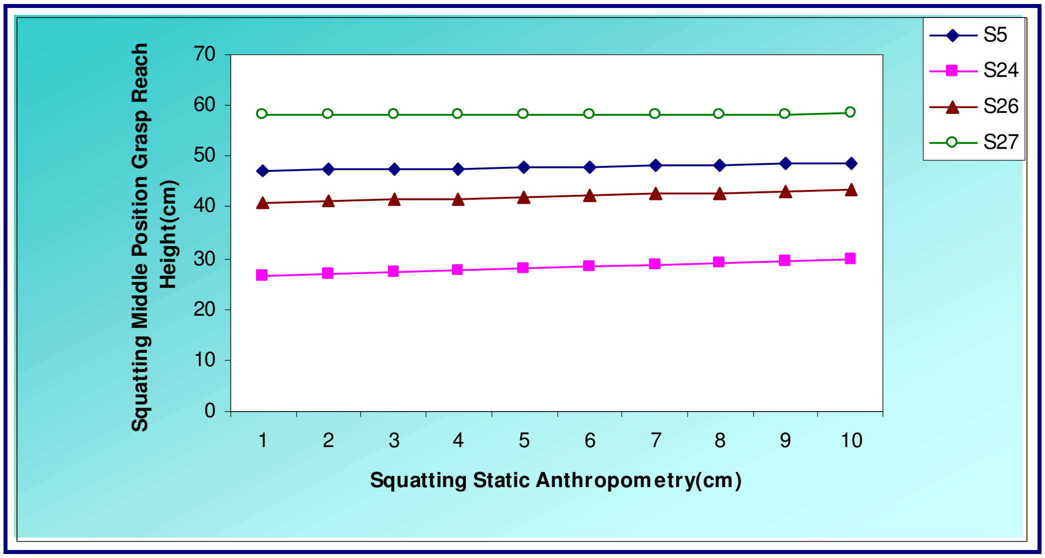


Figure 83: **Regression analysis between squatting static anthropometry and Squatting Mid Position Grasp Reach Height (D_{38}) of women**

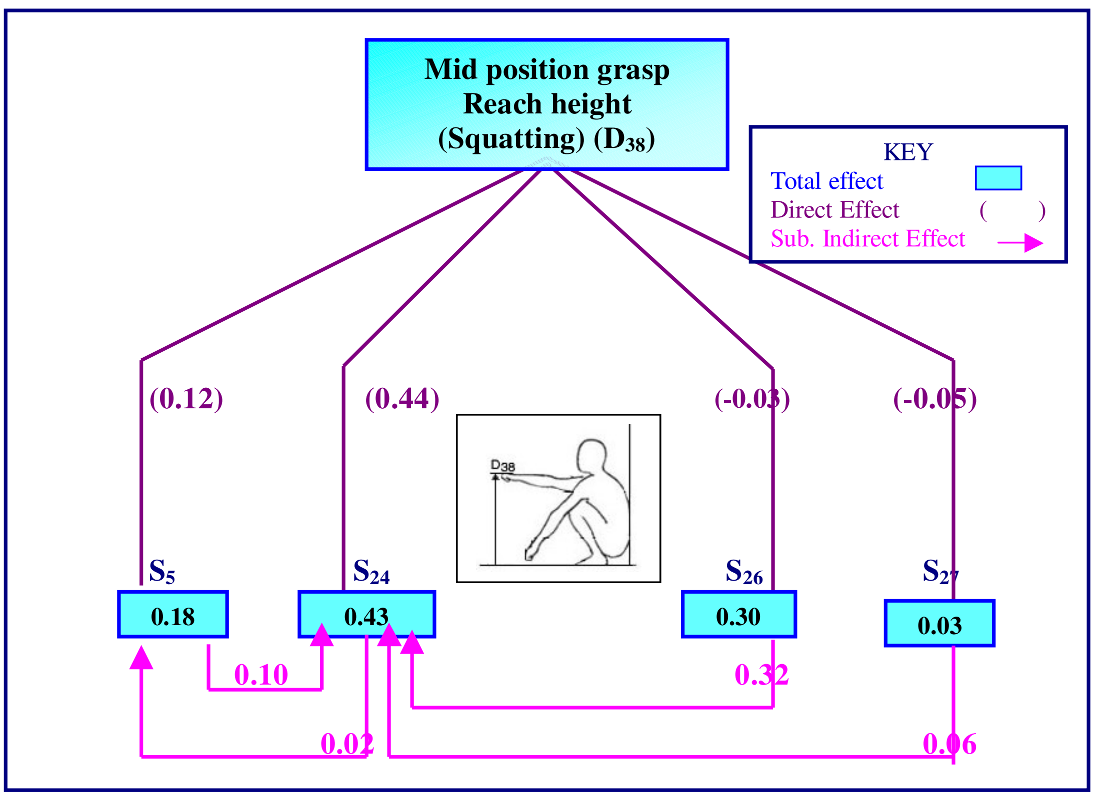


Figure 84: **Path analysis between squatting static anthropometry and Mid Position Grasp Reach Height (D_{38}) of women**

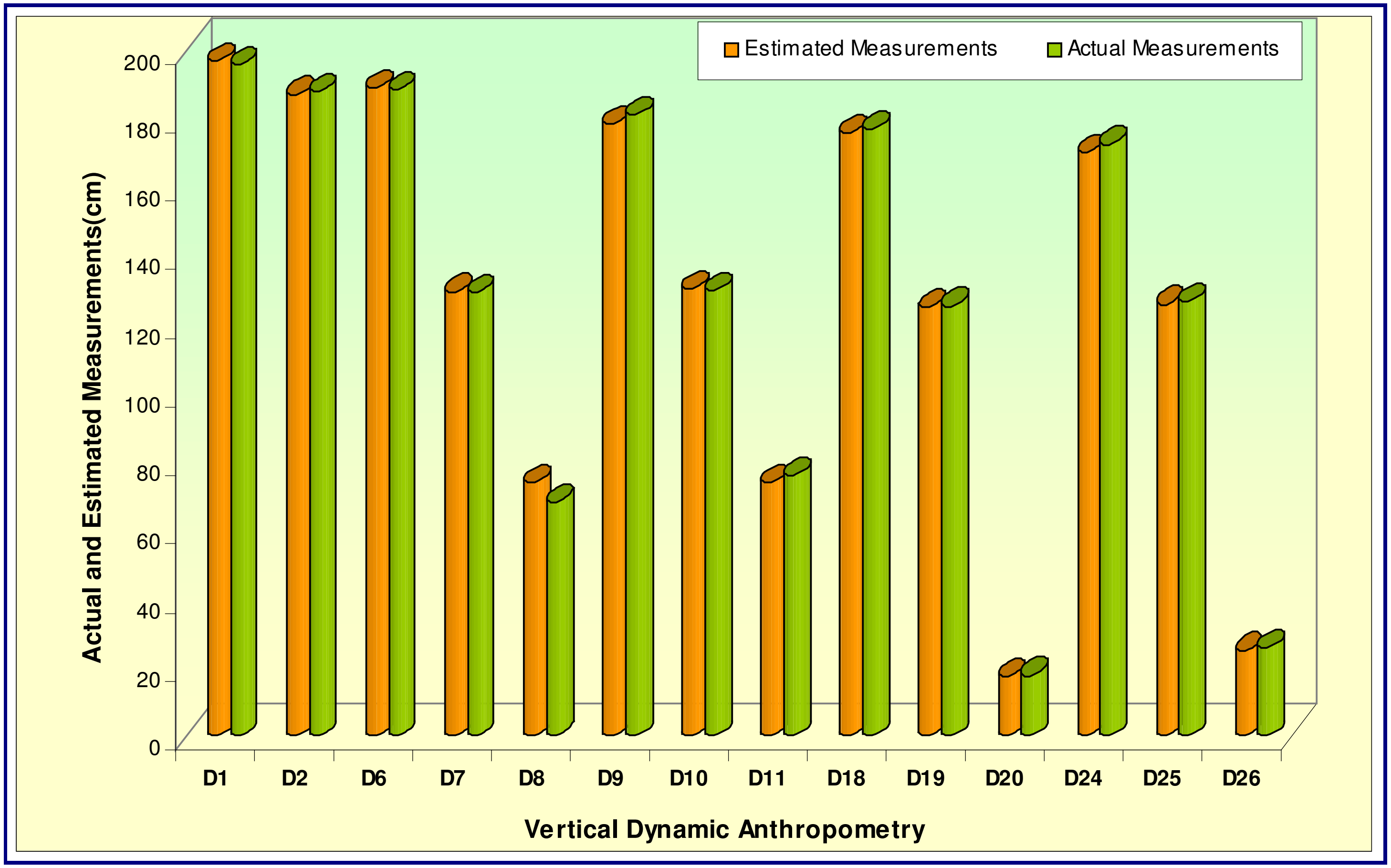


Figure 85: **Comparative assessment of observed & predicted estimates of standing vertical dynamic anthropometry of women**

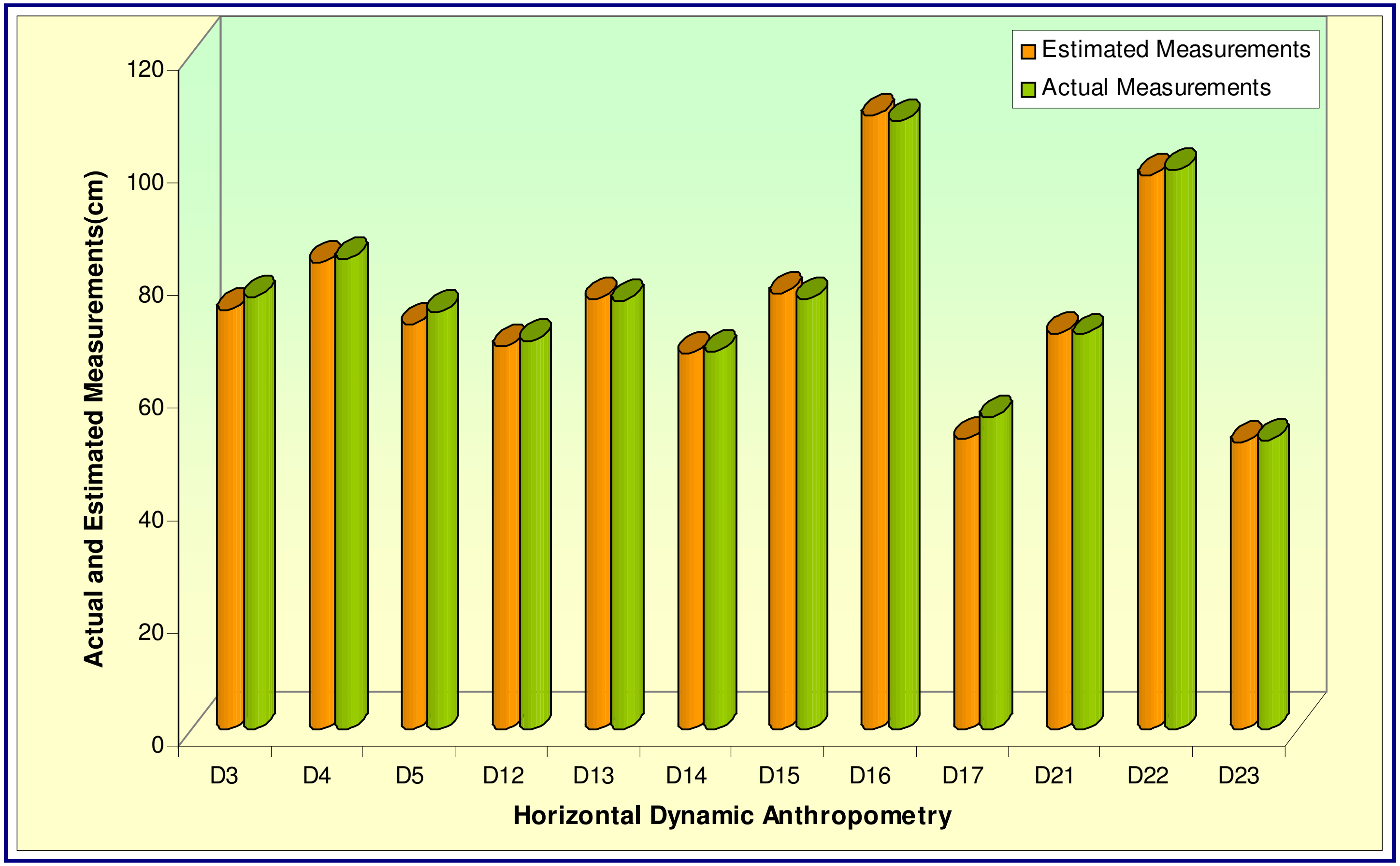


Figure 86: **Comparative assessment of observed & predicted estimates of standing horizontal dynamic anthropometry of women**

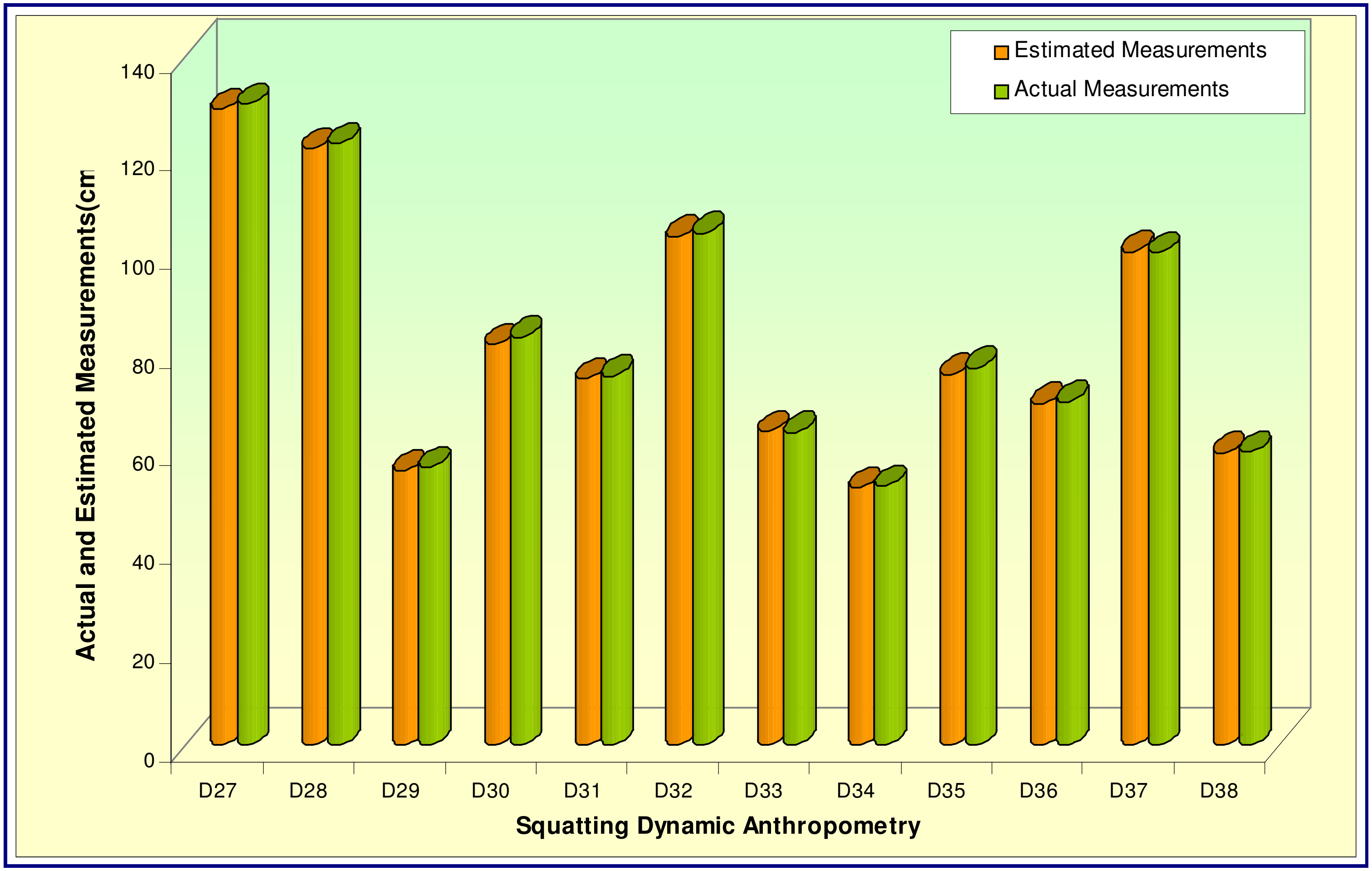


Figure 87: **Comparative assessment of observed & predicted estimates of squatting dynamic anthropometry of women**